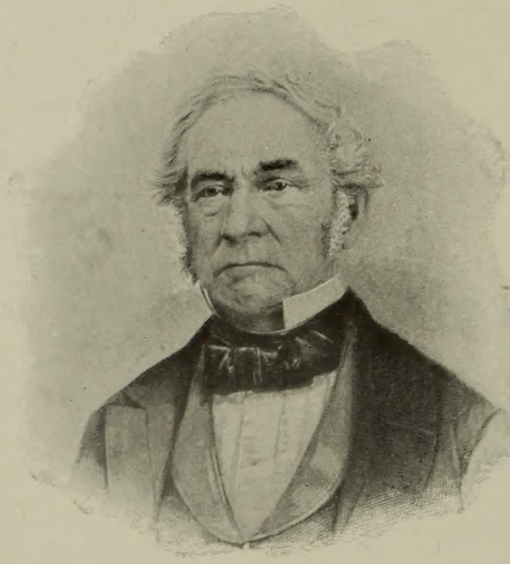

HENRY LEAVITT ELLSWORTH, OF CONNECT

[BORN NOVEMBER 10, 1791; DIED DECEMBER 27, 18

Hon. Henry L. Ellsworth was Commissioner of the Patent Office fr
had taken charge of certain agricultural interests, in consequen
with patents for improvements in agricultural implements.
interested in the introduction of new crops and in the improve
This led him to collect seeds and plants of new and improve
States consular officers, and to distribute them under the fra
Congress. Finally, his suggestions and arguments led to the
for the purpose of collecting and distributing seeds, prosecuti
and procuring agricultural statistics. In 1840 he distributed
1842 statistics were published, with a survey of crop condition
Government aid to agriculture in the Unite

YEARBOOK

OF THE

UNITED STATE

DEPARTMENT OF AGRICUL

1902.

[CHAPTER 23, Stat. at L., 1895.]

[AN ACT providing for the public printing and binding and the distribution of public documents.]

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Section 73, paragraph 2:

The Annual Report of the Secretary of Agriculture shall hereafter be submitted and printed in two parts, as follows: Part One, which shall contain purely business and executive matter which it is necessary for the Secretary to submit to the President and Congress; Part Two, which shall contain such reports from the different Bureaus and Divisions, and such papers prepared by their special agents, accompanied by suitable illustrations, as shall, in the opinion of the Secretary, be specially suited to interest and instruct the farmers of the country, and to include a general report of the operations of the Department for their information. There shall be printed of Part One, one thousand copies for the Senate, two thousand copies for the House, and three thousand copies for the Department of Agriculture; and of Part Two, one hundred and ten thousand copies for the use of the Senate, three hundred and sixty thousand copies for the use of the House of Representatives, and thirty thousand copies for the use of the Department of Agriculture, the illustrations for the same to be executed under the supervision of the Public Printer, in accordance with directions of the Joint Committee on Printing, said illustrations to be subject to the approval of the Secretary of Agriculture; and the title of each of the said parts shall be such as to show that such part is complete in itself.

PREFACE.

The Yearbook for 1902 is slightly more bulky than its predecessors. It is satisfactory to note, however, that this result is due not to an increase in the length of the articles contributed but to continued expansion in the Department work—the multiplication of the branches of work which should be represented in the pages of the Yearbook. As a matter of fact, the 37 articles which form the bulk of the volume will average fewer pages than those in any former Yearbook. These take up 534 pages, being an average of a little over 14 pages to an article. The corresponding portion of the Yearbook for 1901 aggregated 492 pages, containing 33 articles, averaging 15 pages; while the corresponding figures for the Yearbooks for 1900 and 1899 were, respectively, 552 pages, 31 articles, averaging nearly 18 pages, and 593 pages, 26 articles, averaging nearly 23 pages.

It has been impossible in the general effort at reduction to apply it equally to the first part of the Yearbook, which, in compliance with the law requiring the inclusion in each Yearbook of a "general report of the operations of the Department," consists of the Secretary's Annual Report. This record unavoidably expands in some proportion to the continued growth of the Department and the extension of its work along numerous new lines.

The number of plates (87) is the same as in 1900 and slightly less than in 1901, though in view of the increase in the number of articles the reduction is proportionately greater than the actual number shows. In accordance with the general policy of reduction, the illustrations have been carefully restricted to such as are deemed necessary to increase the usefulness of the work and to assist the reader to a full and satisfactory understanding of the text.

As far as the nature of the subjects discussed would permit, the matter has been presented in language as little technical as possible. Both in the nature of the articles presented and in the manner of their presentation the prevailing idea has been that of practical utility. This must evidently be the keynote in the preparation of a publication designed to reach such a vast number of readers as an edition of half a million copies gratuitously distributed is likely to secure.

The Appendix shows no appreciable reduction from last year, though less by over 10 per cent than in 1900. Its purpose to supply a compendium of information useful to all persons interested in agriculture has been kept in view in its preparation, and so far as possible everything not deemed essential to this end has been carefully eliminated. The Appendix contains the usual list of names and post-offices of persons prominent in agricultural work in all its branches. It presents some views of agricultural progress in several directions and a statement of public lands open for settlement. It is believed that any person anxious to obtain information concerning agricultural matters not covered in the Yearbook will find in the lists given the names of persons who can supply it.

The statistical tables with which the Appendix closes present the production, prices, and movement of the principal crops and farm animals, and the deficiency occurring in these figures last year is now supplied, making comparisons again possible.

A very considerable amount of space is necessarily taken up by the Index, a most important feature in a work of this kind, to which 35 or 40 pages are usually devoted.

Reference having been made to the size of the edition and the gratuitous distribution, it should be explained here that the small quota assigned to the Department for its use (only 6 per cent of the whole edition) precludes any possibility of miscellaneous distribution by the Department itself, its own regular correspondents being far more numerous than the total number of Yearbooks placed at its disposal. The bulk of the edition, 470,000 copies, is reserved for the use of Senators, Representatives, and Delegates in Congress for distribution to their constituents.

In the work of editing the Yearbook, the Editor is ably assisted by Mr. B. D. Stallings, whose special charge covers the main part of the work, and by Mr. C. H. Greathouse, whose charge includes the Appendix and the preparation of the Index. For the admirable manner in which these gentlemen have performed the difficult duties assigned to them in this work, the undersigned desires to express due appreciation.

GEO. WM. HILL,
Editor Department of Agriculture.

WASHINGTON, D. C., *May 6, 1903.*

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YEARBOOK

OF THE

U. S. DEPARTMENT OF AGRICULTURE.

REPORT OF THE SECRETARY.

To the President:

The educational work of the Department of Agriculture has grown in effectiveness since my last Annual Report. The opportunities offered to young men to fit themselves for special lines of experimental work under the immediate care of our most experienced scientists are being sought by greater numbers every year. The influence of the Department is extending through cooperation with the scientists of the experiment stations of the several States and Territories and the isles of the sea under our flag. The demands of these institutions for trained men to conduct research into so many fields of inquiry and of private individuals and companies for the best organizing and supervising ability to manage agricultural enterprises encourage students to prepare for doing this work.

The teaching of the science of agriculture and the sciences related to it is receiving more attention in the colleges instituted for this purpose, many of which in the past have neglected their full duty in this regard.

Research by the Department officials into the principles governing the growth of plants and the creation of new species by hybridizing to give varieties from which to select for new purposes has brought gratifying results. We have new fruits and grains of numerous kinds adapted to localities that have been needing them for many years.

We are helping people in many localities to an intelligent knowledge of their soils and of the most profitable uses to which they may be devoted. Results are showing the value of this service. The best sugar lands, rice lands, tobacco lands, truck lands, and lands best adapted to particular fruits, grains, grasses, legumes, and other crops are being discovered as certainly as any other unknown thing is brought to human knowledge for the first time.

Few of the plants of most value to our people are native to the United States. They are products of other countries and have been useful in their localities for long periods of time. Our various soils

and climates are adapted to many things that have not yet been introduced to them. Department explorers are searching the Old World for whatever is valuable there and useful here, with results that are quite encouraging. Our aims are to help toward the production in the States and Territories of everything their soils and climates will permit, and to help our new island possessions to grow whatever products require tropical conditions.

Our growing commerce is accompanied with danger from invasion of animal and plant diseases and parasites calling for vigilance on the part of Department scientists to keep them out and to deal with them when they cross our borders, as they occasionally do.

My last Report showed that the Department was paying $12,600 a year for rent of buildings. It is now paying $21,700, and the amount will increase as the work increases. It would be good business policy to adopt a plan of building adequate to the future needs of the Department, and to authorize the erection of so much of it as would provide for the offices that are now housed in the city wherever room can be had. The sum necessary to provide the rent, at Government rates of interest, would be ample to begin with; besides none of the buildings now in use are fireproof, and we have materials that have accumulated in our laboratories, in addition to a unique library, that could not be replaced if destroyed by fire.

WEATHER BUREAU.

FORECAST WARNINGS.

The past year affords gratifying evidence of the value of forecast warnings of the Weather Bureau in saving life and property. People of other nations express appreciation of our Atlantic weather forecasts. The universal appreciation of this service in giving ample warning of the approach of severe storms or hurricanes or of killing frosts is highly gratifying and affords ample testimony of the assertion I have made on previous occasions that the value of property saved from loss repays to the country many times over the cost of maintaining the Bureau.

Substantial increase was made in the distribution of daily forecasts through the rural free delivery, although efforts in this direction were circumscribed for want of funds for the purchase of necessary supplies. On August 1, 1902, there were in operation about 10,000 rural free-delivery routes, serving approximately 1,000,000 families. For the reason stated, only 105,000 families, served by about 1,000 routes, could be furnished with the forecasts of the Bureau. According to the estimates of the Post-Office Department, there will be in operation July 1, 1903, 15,000 routes, serving approximately 1,500,000 families, representing a population of over 7,500,000 people. The distribution

of the daily forecasts of the Bureau should be made coextensive with the rural free delivery. This could be done on the basis of the Post-Office estimates for July 1, 1903, at a cost of about $100,000.

Wireless Telegraphy.

The experiments in space, or wireless, telegraphy were begun January 1, 1900, under the direction of the Chief of the Weather Bureau, and were continued during the past year. While much valuable information has been secured and a fairly satisfactory experimental system has been devised, I am not able to report such progress in the investigation as would justify the Department in dispensing with its coast telegraph lines or with the cables that connect certain islands with the mainland.

Storm Warning Equipment.

As far as funds would permit, the work of extending the equipment of steel towers and high-power lanterns of improved type at important storm warning stations was pushed energetically during the year by the instrument division. In all, 54 towers were distributed to storm warning stations.

The funds available were too limited to permit of the purchase of high-power lanterns and other accessories required by the towers. Moreover, the first six months of the past year have been necessarily consumed in the manufacture, shipment, and installation of the towers. The matter of lanterns and accessories will therefore have to be supplied this year, and while provision for them has already been made, the storm-warning fund will permit of no considerable extension of the work, and we must of necessity confine ourselves to finishing up the work left over from last year. There are now 109 storm-warning and 9 special stations at which the steel towers have been installed. Of these, 48 need lanterns, and they will be issued as soon as delivered by the contractors.

Under the special appropriation by Congress for the purchase of sites and the erection of buildings for the use of the Weather Bureau at certain stations, buildings were erected at the following places, at a total cost of $23,932.53, namely: Atlantic City, N. J.; Hatteras, N. C.; Fort Canby (North Head), Wash.; Port Crescent, Wash.; Tatoosh Island, Wash., and Point Reyes, Cal. Under this appropriation, also, buildings were repaired and improved and supplies provided, at a cost of $17,279.03, at the following places: Bismarck, N. Dak.; Jupiter, Fla.; Kittyhawk, N. C., and Cape Henry, Virginia. The buildings at Port Crescent, Wash., and Jupiter, Fla., are still in course of construction, but will be completed within a few months. In view of the approval of this policy and of the economy to the Government of owning its own buildings, I recommended an additional appropriation of $50,000, which

was duly granted by Congress, for the purchase of sites and the erection of not less than six buildings during the current fiscal year. The places selected for these new buildings are Yellowstone Park, Wyo.; Amarillo, Tex.; Modena, Utah; Key West, Fla.; Sand Key, Fla., and South Farallone Island, California. Owing to the difficulty in providing sites for the buildings at Amarillo and Modena, it will hardly be practicable to erect buildings there before next spring.

The crop service of the Bureau will be dealt with in a special report called for by Congress.

BUREAU OF ANIMAL INDUSTRY.

Inspection Service for Export Animals.

The act of Congress of August 30, 1890, provided for the inspection by the Bureau of Animal Industry of meats for exportation, and this was supplemented on March 3, 1891, by an act providing "for the inspection of live cattle, hogs, and the carcasses and products thereof which are the subjects of interstate commerce, and for other purposes." This law was amended by an act which took effect July 1, 1902, providing for the inspection of dairy products for export. Under these laws important service to the live-stock industry has been performed.

The total number of ante-mortem inspections was 59,158,648, being an increase over the previous year of 2,789,338. The cost of these inspections was 1.08 cents each. The number of post-mortem inspections was 38,903,625. The carcasses condemned numbered 61,980, besides 17,445 parts of carcasses.

The meat-inspection tag or brand was placed upon 19,694,665 quarters, 250,141 pieces, and 3,820 sacks of beef, 7,419,287 carcasses of sheep, 554,016 carcasses of calves, 1,253,083 carcasses of hogs, and 793,471 sacks of pork.

The meat-inspection stamp was affixed to packages of meat products that had received the ordinary inspection as follows: 7,166,490 of beef, 39,229 of mutton, 8 of veal, 15,835,520 of pork, and 638 of horseflesh, a total of 23,041,885.

The number of cars sealed containing inspected meat products for shipment to official abattoirs and other places was 64,730.

The number of certificates of ordinary inspection issued for meat products for export, exclusive of horseflesh, was 32,744. Of beef there were 1,571,305 quarters, 19,728 pieces, 3,845 bags, and 1,582,549 packages, with a weight of 416,990,762 pounds; of mutton there were 85 carcasses and 26,942 packages, weighing 1,145,248 pounds; of pork there were 94,962 carcasses and 658,139 packages, weighing 188,360,011 pounds. These figures show a decrease from the previous year of

35,839,611 pounds of beef and 42,784,927 pounds of pork. There were 11 certificates issued for horseflesh, the export consisting of 638 packages, weighing 170,968 pounds.

The quantity of pork examined microscopically, which was exported, amounted to 33,681,229 pounds. This was a decrease of a little more than 2,000,000 pounds from the previous year, owing to a decreased demand for pork from those countries demanding inspection. The cost of this work per pound was 0.368 cent.

The value of the exports of animals and animal products for the year ended June 30, 1902, amounted to the large sum of $244,733,062. Of this amount, $44,871,684 was the value of the animals, $192,756,608 of the meat and meat products, and $7,104,770 of the dairy products. The total value of the exports of animal products was about $3,000,000 greater than the like exports of the previous year, but there was a decrease of nearly $8,000,000 in the value of cattle exported. This was due to the sharp demand for beef cattle in this country.

Of the 392,884 cattle exported, 295,346 were inspected, tagged, and certified as to health. The others shipped were from ports where inspection is not provided and is made to countries where a Government certificate of inspection is not required. Of sheep, 401,132 were inspected and 212,178 were certified for export; of horses, 19,990 were inspected and 10,975 certified for export. The value of the cattle exported was $29,902,212; of horses $10,048,046; of mules $2,692,298; of sheep $1,940,060.

The inspection of vessels for carrying live stock has been conducted with a view to the best possible service and the most humane treatment of the animals. The percentage of loss in ocean transit of cattle is now reduced to 0.13 for cattle, 0.89 for sheep, and 0.65 for horses.

The number of clearances of vessels carrying live stock was 837, which was considerably less than for the previous year—a condition due to the decreased exports of cattle and horses.

Inspection Service for Import Animals.

There were inspected and admitted from Mexico 65,213 cattle, 3,776 sheep and lambs, and 2,090 goats; also a few asses, horses, mules, and hogs. Through ports on the seacoast, horses not subject to quarantine were imported to the number of 2,283.

One of the most important duties of the Bureau of Animal Industry is to maintain strict quarantine at the ports of the seacoast in order to prevent the introduction of animal plagues. The efficiency of this service has been shown in the past, and it is a service by which the live-stock interests of our country are directly conserved. The live-stock growers demand and receive the most rigid inspection at these ports, for it would be no difficult matter to permit the introduction of diseases which might easily cost the live-stock growers many millions

in direct losses, and at the same time the Government would be under heavy expense in efforts toward their eradication.

We imported from Canada 27,716 cattle, 148,313 sheep, 3,305 horses, and 5,356 hogs which were not subject to quarantine. There were also imported and quarantined 1,214 cattle, 231 sheep, and 33 hogs. Besides these there were quarantined animals of various species which were destined for menageries and zoological parks.

For the purpose of preventing the importation of cattle affected with tuberculosis a veterinarian has been stationed in Great Britain, whose duty it is to test with tuberculin all cattle over six months old which are destined for export to the United States. During the year 1,067 cattle have been so tested, of which 928 were passed and 139 rejected. These cattle were representatives of nine different breeds, those predominating being Hereford, Jersey, and Shorthorn.

Exports of Dairy Products.

Experimental exports of dairy products have been made to Japan, China, Cuba, and Porto Rico. This method of making known the better grades of these products has resulted in somewhat increased sales by merchants in San Francisco and New York and some parties elsewhere; but inadequate and unsuitable transportation facilities, the destructive climates of some of the markets referred to, and other unfavorable conditions prevent any rapid increase in this trade. The results indicate, however, that the markets of Japan may be further cultivated.

Under act of Congress of March 2, 1902, the dairy division of the Bureau inaugurated a system of inspection of dairy products offered for export, affixing stamps to the same, and certifying to the character and quality of the articles. Domestic prices, however, have been so high as to prevent any considerable export of high-grade goods other than condensed milk and cream.

Contagious Diseases.

The work of this Bureau with reference to contagious diseases of animals, which has been prominent from the time of its organization, has been continued. This work at present includes the control of Texas fever, blackleg, sheep scab, and maladie du coït, while scientific investigations are in progress to determine the nature and best methods of treating other important diseases, such as tuberculosis, hog cholera, and anthrax. The records show that 1,688,565 doses of blackleg vaccine were distributed during the year, and the reports of its use reduce the loss of cattle after using it to 0.51 per cent of those vaccinated. If we should eliminate from these reports those cattle which were presumably infected before vaccination, and also those

which probably died because a mistake was made in the operation, the percentage of loss would be reduced to 0.44. These results indicate that the use of this vaccine has saved to the stock raisers many thousands of head of cattle and consequently a very large sum of money.

BUREAU OF PLANT INDUSTRY.

In accordance with the recommendations in my last report, Congress brought within the scope of this Bureau four additional lines of plant work, viz, the Arlington Experimental Farm, the investigations in the production of domestic tea, the work on foreign seed and plant introduction, and the Congressional seed distribution. It has necessarily required much time to perfect this reorganization, but everything in this direction is now practically complete and the nine main branches of the Bureau are being so conducted as to bring forth the very best work. Much of the success of any work in the Department depends, in the first place, upon good men, and, in the second place, upon giving such men responsibilities of a nature that will develop their best efforts. This policy is followed in the Bureau of Plant Industry, and as a result there is an earnest corps of workers, each knowing his duty and performing it with all the energy at his command. Owing to the fact that much of the detailed work connected with the reorganization was completed last year, it has been found practicable the present year to devote considerable attention to the development of new fields, a few of which may be briefly referred to here.

The nature of the work of this Bureau is such that cooperation with the State experiment stations is an important factor, and for this reason very close relationships have been established with station investigators in about thirty States. The work undertaken conjointly with these stations is of the most varied character.

Farm Management.

As the work of reorganizing this Bureau developed, the need was felt for properly coordinating all the varied lines of plant work in such a way that they could be brought directly home to the practical farmer and fruit grower in all parts of the country. To this end, I have approved the establishment within the Bureau of an office of Farm Management, which shall have for its object the bringing together in concrete form of all the facts developed in the Bureau as a whole, sifting the results, and applying them in a practical way where they will do the most good. To enhance the value of this work general studies have been inaugurated in the matter of securing facts regarding the way in which the best paying farms in the country are being managed, and what are the relationships of surrounding conditions, such as proximity to markets, ways of leasing or controlling the lands, soils,

and climate, and the methods of farming followed. With the knowledge thus secured it will be practicable to lay out a working plan for a particular farm in a particular region, the object being in all cases to have such plans serve as object lessons for type regions rather than for individuals. In line with this plan there is now being undertaken in different parts of the South demonstration experiments for the purpose of showing the possibilities of more diversified farming.

With the cooperation of farmers, working plans are being devised whereby the present system of growing only one crop will be changed so as to secure more diversification, thus insuring greater profits and the building up of the fertility of the land. There are many thousands of acres in the South where the same system of farming has been carried on for years and where it would be a great advantage to inaugurate changes which would lead to the building up of the fertility of the soil and give broader opportunities to those handling the same. As a specific example of this work there is now being developed in the South, as object lessons, a system of what will be called "one-man" farms. These are small areas of land in the pine woods region upon which a system of farming is being developed of such a nature as to appeal directly to the class of farmers who must necessarily handle such land. Instead of a single crop, simple systems of rotation are being put into operation, and the question of the proper stock to keep is being considered, all being of such a nature that the work can be handled by one individual. In other regions, where the conditions are different, more elaborate plans are under way whereby considerable tracts of land which have for years been cropped to cotton are being arranged for a regular rotation, introducing stock as an element for the purpose of showing the possibilities of such diversification and its bearing on the welfare of the different communities.

Extension of Fruit Markets Abroad.

With the increasing production of special crops there is felt the urgent need for broader markets. This is particularly the case with perishable products, such as fruits and certain kinds of vegetables. There have lately been undertaken, in a limited way, some investigations having for their purpose the extension of the export trade and the improvement of the methods of handling these products for foreign and domestic use. Several experimental shipments have included summer apples, peaches, fall pears, and sweet potatoes—products in which an export trade is undeveloped; and winter apples, in which there is a large and increasing trade, but in which it is desirable to bring about improvements in the methods of handling and shipping.

The results so far obtained indicate that the first-named products may be landed in European markets in good condition if proper care is exercised in all of the operations from the orchard or field to the

final destinations. A net return has been realized equal to, and in most cases in excess of, domestic values. It is shown also that the net return for a given fruit is largely influenced by the kind of package in which it is forwarded, and by the methods of packing and shipping it.

These preliminary investigations have already encouraged growers to ship some of these fruits in a commercial way and to adopt the suggestions brought out by the Department investigations. The fruit export trade needs careful investigation, both at home and abroad, in order that the methods of the American fruit grower may conform more closely to the foreign practices of handling and distributing our fruits and to the requirements of the foreign consumer.

I wish here to point out the necessity in work of this kind for a thorough and systematic study of the different foreign markets, in order that the American farmer and fruit grower may act intelligently in making shipments. To this end a plan is being devised whereby an experienced man will be sent to one or more of our most promising foreign markets to study all the prevailing conditions, and to secure and handle experimental shipments of fruits and vegetables, noting the condition in which various shipments arrive, the methods of packing which give the most satisfactory results, and looking after numerous other details which can be determined in no other way. Such an agent would also be in a position to secure valuable facts regarding the products with which we are compelled to compete, and would be able to point out methods by means of which we could best meet this competition.

To make this work still more valuable, the Department's agent or agents could do much toward enlightening the general public in such foreign countries in regard to the value of our products for general consumption. There is no reason why many of our fruits and vegetables can not be sent abroad and sold at a price that would place them within the reach of the average consumer, provided he was aware that he could obtain them, and knew something of their value as food. In other words, it seems that the time has come for decisive action in the matter of exploiting abroad such products as have been mentioned; and to accomplish this with the best results trained men, and men of good judgment, will be required. If sufficient funds are available, it is planned to inaugurate this work the forthcoming year in a limited way.

Plant Physiology and Pathology.

The practical utility of thorough scientific investigation of agricultural problems is nowhere better demonstrated than in the Department's work in the broad field of physiology and pathology. While the greatest scientific accuracy is demanded on the one hand in the study

of the normal and abnormal or diseased condition of plants, on the other hand no effort is spared to make the knowledge thus obtained of practical use. Following are some of the results of the work of the past year.

PLANT DISEASES.

PEAR BLIGHT.

This disease, also known as fire blight or apple blight, is the cause of heavy losses annually. It has been especially severe for the past two years in the Southern and Pacific Coast States. The Department several years ago discovered improved methods of treating this disease, and during the past year a large field demonstration of the method was made in Texas in a place where the disease was so severe as to thoroughly test the treatment. This experiment, on a commercial scale, was entirely successful. Four to five thousand bushels of fruit were saved in the treated orchard, while in the untreated adjacent orchard the fruit was destroyed by the disease and the trees greatly injured. Similar demonstrations will be carried out next year in other parts of the United States.

LITTLE PEACH.

Some important discoveries were made during the year in regard to this rapidly spreading disease. In some respects it appears to be almost as serious a trouble as the dreaded peach yellows, and, as in the case of that disease, the Department recommends immediate destruction of the diseased trees. If this is promptly done the disease may be largely stamped out. No resistant stocks have yet been found, though careful search is being made for them.

BITTER ROT OF APPLES.

This disease is one of the worst with which the apple grower has to contend. For the past three years it has destroyed millions of dollars worth of fruit on the trees and millions of dollars worth in the hands of commission men. The method of treating this disease has, in the past, been only partially successful. An agent of the Department has lately discovered that the infection spreads from diseased canker spots on the limbs to the fruit. This discovery will enable us to much more thoroughly control the disease, if not to prevent it entirely. The spraying experiments this year have also been very successful.

BACTERIAL DISEASE OF ENGLISH WALNUTS.

One of the most important industries of southern California is the growing of English walnuts. For several years a disease has been gaining headway in the orchards and has caused great loss. The

Department's experts on the Pacific coast have been studying the trouble and have been especially successful during the past year in improving the methods of combating it. While much still remains to be accomplished, a treatment has been found which will greatly reduce the injury done by the disease.

DECAY OF FOREST AND CONSTRUCTION TIMBER.

Rapid progress has been made during the year in the study conjointly with the Bureau of Forestry of the diseases of forest trees. Special attention has been given to the diseases in the great forest reservations, and practical methods of controlling some of them have been devised.

Recently a serious heart-rot disease of catalpa has appeared in some of the western catalpa plantations. A Department expert has studied this rot fungus, found out what it is, and has devised a method to protect the trees against it in the future. The importance of this is apparent. The planting of catalpa groves is increasing in several of the Western States. The wood is very durable, making good fence posts, telegraph poles, etc.

One of the most important subjects connected with the utilization of forests is increasing the durability of wood when used for construction. A careful study of the various methods of preserving wood was begun the past year by Department experts and much valuable information obtained. The organisms causing decay of fence posts, sills of buildings, railroad ties, telegraph poles, bridge timbers, greenhouse benches, etc., practically all belong to the group of fungi. The Department believes that cheap and effective methods of treating lumber so as to prevent this decay can be found, and considerable progress was made in this direction the past year.

PLANT BREEDING WORK.

DISEASE-RESISTANT CROPS.

The most practical way to fight disease is to use nature's method and get disease-resistant or immune plants. Striking success has been achieved by the Department experts in this line. The development of cotton resistant to wilt disease is now an assured fact and has been taken hold of by the planters on a large scale. Large tracts of land in the Sea Island district of South Carolina which had been abandoned on account of this disease were planted the past year successfully with resistant strains of cotton, and good crops secured. The discovery during the past year of a variety of cowpea—"Little Iron"—resistant to "wilt" and "root-knot" (two of the worst diseases of this important crop in the South) is a matter of great importance to Southern agriculture, where the need of leguminous crops for forage and

soil improvement is especially felt. Thirty bushels of seed of this resistant variety were distributed during the past year.

Satisfactory progress was made during the year in securing varieties of cotton resistant to the Texas root-rot, and some evidence was obtained that varieties may be developed resistant to the dreaded cotton boll weevil.

BETTER UPLAND COTTONS.

One of the greatest needs in improving the cotton industry of the United States has been to secure a long-staple Upland variety which is of good quality and productive.

The long-staple Upland varieties at present existing are all of them rather light producers, and are defective in that the fiber is borne on fuzzy or tufted seed, which makes them difficult to gin.

The aim of the Department's experts has been to secure productive varieties with large bolls, easy to pick, with fine, strong lint from 1¼ to 1¾ inches long, borne on a smooth black seed. Many hybrids were made with this in view and the result has been successful beyond our expectations. Several varieties of the ideal type desired have been produced, having larger bolls, very productive, with long, fine fiber, borne on smooth black seeds. The experiments of the past year show quite conclusively that these varieties can be made permanent.

Egypt and South Africa are waking up to their possibilities in cotton production, and they are already endeavoring to get some of our experts to help them to develop the industry in competition with the United States. The only way we can continue to maintain our supremacy in the future is to develop and grow better and more productive varieties than will be grown by our competitors.

HARDY ORANGES.

The work of developing frost-resistant oranges was started several years ago, and the progress of the work has been reported from time to time. During the past season we have obtained the first fruits of these hybrids. These are intermediate in character between the Florida sweet orange and the hardy trifoliate, and have good, though few, seeds. There is therefore strong probability that from the seeds of these fruits we shall obtain numerous varieties with the qualities desired.

WHEAT BREEDING.

Several of the Russian winter wheats are superior to the American varieties; still there is room for improving on the Russian varieties. As a rule Japanese varieties are early maturing, while the better Russian sorts are late. Hybrids between the Japanese and Russian varieties have already been obtained having the good qualities of the hardy Russian sorts and the early ripening quality of the Japanese. Early

varieties often escape the worst periods of drought and are less likely to be injured by rusts and other fungous and insect pests. Gratifying progress has also been made during the year in breeding rust-resistant varieties and nonshattering sorts.

NITROGEN-GATHERING BACTERIA.

Attention was called in my last report to the importance of nitrogen in the nutrition of plants, and the discovery of a new method of cultivating the bacteria which gather nitrogen in connection with leguminous crops was announced. This method has been perfected during the past year. The reason for the failure of former work in this line, both in this country and Europe, has been determined, and a new, simple, cheap, and thoroughly satisfactory method of growing and distributing the tubercle bacteria for all the important leguminous crops has been perfected. The nitrogen-gathering power of the bacteria grown by our new method is at least five times as great as the nitrogen-gathering power of the ordinary forms found in nature, and the new forms, instead of being restricted to certain legumes, have a much wider range of activity. Field tests on a large scale were started during the year, and advance reports from the cooperating farmers show extremely favorable returns from the use of these organisms.

Botanical Investigations and Experiments.

During the year the botanical investigations of this Bureau were pushed forward with vigor. Some of the more important results accomplished in this field are outlined below:

THE COMMERCIAL GRADING OF GRAIN.

A movement to secure an improvement in methods of inspection and toward greater uniformity in work of inspection departments of the large grain markets is now well begun, as a result of an organization of the chief inspectors of these markets. The interest manifested in this movement by all branches of the grain trade gives reason for believing that there may result from it a system of inspection and grading, maintained by the trade organizations, which shall be honest, efficient, and uniform throughout the country, and which shall insure to the farmer a premium for high quality of product, and to the consumer the quality of grain he demands and pays for. The Department is aiding this movement as much as possible by cooperating with these chief inspectors in working out simple and practicable methods for determining and accurately stating the quality of grain and studying causes and methods of prevention of deterioration of grain in storage and in transit.

AMERICAN AND EUROPEAN RED CLOVER SEED.

The study of the merits of red clover of American as compared with that of European origin has been continued, with the cooperation of a number of agricultural experiment stations in the clover-growing States. From the 1901 plantings the results were practically the same as those of the year before in the testing garden at Washington. The European clovers were not able to stand the hot and dry periods of our summer, but suffered badly from sun scald, and were generally of a much lighter color and less thrifty than those from our own seed. The same facts hold true for the plantings made this year, and it is evident that the European clover, unless it be some from the extreme north, is not adapted to the clover-growing sections of the United States.

NEW REMEDY FOR SHEEP POISONING ON THE STOCK RANGES.

The great stock ranges of the Northwest contain approximately one-third of the sheep in the United States, representing a value of more than $40,000,000. The owners of these sheep suffer an annual loss conservatively estimated at 1 per cent, or $400,000, from poisonous plants. During the past year the Department has continued its investigation of this loss and has succeeded in isolating poisonous principles from the species of camas and from one of the lupines, the two kinds of plants which, next to the loco weeds, cause the greatest percentage of loss in the Northwest. The antidote for poison camas announced by the Department in 1900, viz, drenching with a 1 per cent solution of permanganate of potash and sulphate of aluminum, while effective, can be successfully applied by one man to only a few sheep. Some remedy was demanded which could be more quickly applied when a large number of sheep are poisoned. Our physiological tests of the active principle of poison camas on rabbits and other small animals, subsequently verified with sheep, showed that considerable quantities of the poison passed from the system in the urine. A series of tests was then instituted with drugs that are known to stimulate the action of the kidneys. It has now been demonstrated that a combination of diuretin and caffeine is a satisfactory antidote for this poison; and as it can be given very rapidly by means of a hypodermic syringe, one man can apply the remedy to several hundred sheep in a few hours.

AN IMPORTANT STEP IN HEMP CULTURE.

More than nine-tenths of the hemp produced in the United States is grown in Kentucky, and at present prices it is regarded as second only to tobacco in profit as a farm crop. It yields a good profit there, notwithstanding the fact that practically no labor-saving machinery or

improved methods of handling the crop have been introduced. The hemp is nearly all cut by hand, and after much laborious handling in the process of curing and retting it is broken on a hand brake. In Nebraska, where the industry is being established, a new and important step has been taken in cutting the crop with an ordinary mowing machine. A simple attachment, which bends the stalks over in the direction in which the machine is going, facilitates the cutting. The work is regarded as not much more difficult than that of cutting clover or alfalfa, and one man with a span of ordinary farm horses and a mowing machine that has a 5-foot or a 6-foot cutting bar will mow about 10 acres per day. The cost of cutting hemp in this manner is 50 cents per acre, as compared with $3 to $4 per acre, the rates paid for cutting by hand in Kentucky.

The hemp, after being mowed, is left where it falls until retted, except where it is especially heavy. In that case it is necessary to turn it to secure uniformity in curing and retting. It is then raked up and taken to the mill, where the fiber is extracted by means of a series of fluted rollers and beaters. By these methods hemp tow is produced nearly equal in value to Kentucky rough hemp, and at a total cost, exclusive of rent of land, of about $20 instead of $45 per ton.

THE UTILIZATION OF FLAX STRAW.

Efforts are being made to utilize the fiber contained in the thousands of tons of flax straw produced from the flax raised for seed in the Dakotas and Minnesota. Heretofore most of this straw has been burned to get it out of the way. Now large quantities, after being cut and thrashed in the ordinary manner, are subjected to a breaking process which produces a fiber of excellent quality for paper pulp and also a fair grade of fiber for textile purposes. During the past season satisfactory results have been obtained in the use of North Dakota flax for the manufacture of binding twine.

DEVELOPMENT OF THE SISAL INDUSTRY.

The demand for sisal for the manufacture of binding twine is rapidly increasing, owing largely to the advent of the corn binder. The sisal plant is very exacting in regard to the conditions under which it may be cultivated successfully, and, as the areas having the proper conditions for its growth are comparatively limited, it is of the utmost importance to our American consumers of binding twine, as well as to the fiber producers in our tropical territories, that land suitable for the growth of the sisal plant be utilized so far as possible. These facts have been accentuated by the high prices paid for sisal fiber during the past year. A brief investigation has been made of the sisal industry in the Bahamas, where the conditions are somewhat similar to those in

Porto Rico. Some sisal plants from the Bahamas have been sent for trial to the Porto Rico experiment station at Mayaguez. There seems to be little doubt that the sisal plant can be successfully cultivated in limited areas in Porto Rico, as it is now being cultivated in Santo Domingo. It has been introduced into Hawaii, and the first commercial crop has been harvested there during the past season, the fiber produced finding a ready market at good prices in San Francisco.

THE MANGO AND ALLIGATOR PEAR IN PORTO RICO.

Reports are in preparation advising the extensive planting of superior varieties of mangoes and alligator pears in Porto Rico, to supply the increasing demands of the markets of our Eastern cities. That these fruits are not already as popular in the United States as bananas and oranges is due to the fact that there has been no adequate or regular supply of good quality. Porto Rico offers natural conditions very favorable for their culture, and improved facilities of transportation have simplified the commercial problem. Varieties much superior to those now grown for home use in Porto Rico have been found by representatives of the Department in Guatemala and Mexico.

CULTURE OF THE CENTRAL AMERICAN RUBBER TREE (CASTILLOA).

It is generally supposed that a continuously humid climate is necessary for rubber culture, but in southern Mexico it is obvious that an alternation of distinct wet and dry seasons is favorable to the production of rubber by Castilloa, which will permit a much wider use of this tree in our tropical islands than has appeared possible hitherto. The failure of some of the earlier experiments may be ascribed to planting in situations too uniformly moist. The tree will often grow luxuriantly where it will produce little or no rubber, as many planters have learned to their cost. Rubber is the most important vegetable raw material now imported for manufacture in the United States. The agricultural production of rubber is assured, and several millions of capital from the United States have been invested already in Mexican rubber plantations. The extent, however, to which these and similar enterprises in other countries can be made profitable depends on the solution of many new agricultural problems.

COFFEE SHADE.

The coffee industry of Porto Rico has been injured by the presence of too many shade trees in the plantations, owing to the belief of the planters that heavy shading is necessary. A study of the flourishing coffee industry of Guatemala establishes the facts that coffee of the highest grade can be grown entirely without shade, and that the diminution of shade lessens the ravages of the Central American leaf dis-

ease. The general opinion that the foliage and fruit of the coffee shrub are benefited by shade is erroneous, but the shading of the ground is often a cultural advantage. The nitrogen-collecting powers of leguminous shade trees have also contributed largely to the good effects commonly ascribed to shade, so that the selection of the best leguminous shade trees and soiling crops is of much importance to the coffee planter.

Pomological Investigations.

Fruit growing is the dominant type of agriculture in many parts of the country. Formerly it was an incidental feature of farm management. Now enough of certain kinds are grown for domestic use, and a large export trade has been developed. America grows fruit on an extensive scale in contrast with the small, garden-like areas of Europe. In America fruit is a common article of diet; in European countries it is a luxury. Europeans are beginning to know and value American fruits, but the principal consuming population of Europe is yet unacquainted with them. There are great possibilities in the export trade.

Domestic practices in culture and in methods of handling and marketing fruits are in need of improvement. Greater knowledge concerning the adaptability and distribution of varieties is urgent, and knowledge concerning the adaptability of European fruits to American conditions is desirable. Along these lines the pomological investigations of the Department have been largely proceeding since my last report, and in the office the great mass of scattered information on pomological matters and pomological collections is being systematized for practical use.

THE COLD STORAGE OF FRUITS.

Cold storage, or refrigeration, is a necessary adjunct to the rapidly developing fruit interests of the country. There is little known about the influences which govern the keeping qualities of fruits and vegetables. The Department is investigating this subject, and has strong support from fruit growers, fruit handlers, and warehousemen. The Bureau of Chemistry is cooperating with the Pomological Investigations in studying the chemistry of fruit-ripening processes. The investigation will require several years to secure general conclusions, but already important commercial results have been obtained.

"Scald," or a skin discoloration, is one of the serious storage difficulties with many apples. The cause is yet undetermined, but the investigations indicate that the susceptibility can be largely reduced by allowing the apples to become more highly colored or more mature than usual before picking. Such fruit also keeps equally well in storage. Pears and peaches, though usually stored with difficulty in a temperature of 36°, keep much better in a temperature not above 32°.

Fruit, like Bartlett pears and peaches, that ripens quickly after picking, and which is stored for a short time only, keeps best in open packages in which there is a free circulation of air which quickly reduces the temperature of the fruit; but winter apples, to be held for a long period, keep best in a closed package, which prevents evaporation from the fruit. The Department is investigating the influence of cultural conditions, methods of transportation, and systems of refrigeration, and the results seem likely to clear up many of the present cold-storage difficulties.

VITICULTURAL INVESTIGATIONS.

The viticultural investigations of the Department relate largely to the introduction of European table grapes into the Southern States, to various problems connected with the propagation of European and native grapes, and to the manufactured products of the grape.

In the experimental vineyard of European varieties at Earlton, Fla., established in 1899, several varieties are very promising and seem worthy of commercial planting in a restricted way. In this vineyard, which is on sandy soil, the distinct superiority of stocks of the Rupestris type over Riparia stocks has been demonstrated for the Vinifera varieties.

In North Carolina the experimental vineyard of similar varieties shows several promising varieties, though the results are less encouraging than in Florida.

An extensive experiment in bench and field grafting of Vinifera grapes has been begun to determine the relative congeniality of different varieties to different resistant stocks and the behavior of the grafted vines on various kinds of soils. This work is planned to have distinct bearing on the grape industry of the South and of the Pacific coast.

An investigation of the influence of dipping grape cuttings in water at different temperatures and for varying lengths of time upon their growth, and to destroy the Phylloxera, has demonstrated that the limit of safety was reached in a temperature of 50° C. with a five-minute immersion.

Investigations are also in progress relating to stocks that are resistant to the Phylloxera, and which are adapted to the grape growing of the Pacific coast.

The Department is also making a careful study of the methods of manufacturing unfermented grape juice and of its importance as a commercial product.

FRUIT DISTRICT SURVEY.

The adaptability of varieties to the conditions under which they are grown is a matter of fundamental importance, and no question is more

often asked by a prospective fruit grower than "What varieties shall I plant?" The object of this survey is to determine the varieties of the different fruits best suited to the conditions where they are to be grown and to study the influence of conditions upon the behavior of varieties.

The funds available for this work have made it possible only to survey some of the more important sections of the Piedmont region of Virginia, the Blue Ridge section of Maryland, and a portion of a similar area as it extends into Pennsylvania. Much important data regarding the behavior of the numerous varieties of fruits already grown there have been accumulated. This survey is being extended to other fruit-growing sections as rapidly as possible.

In connection with this work an extensive cooperative system of phenological observations has been established. It is expected that these observations, extended over a period of several years, will throw light on several perplexing questions regarding the behavior of varieties and their adaptability to the various fruit-growing regions.

SPECIAL PROBLEMS IN POMOLOGY.

Investigations are well under way with pomological problems connected with the pecan industry, the peach industry, and the citron of commerce industry of the Pacific coast. On all these lines there is a large demand for reliable information, and the Department is preparing to issue publications covering them.

Grass and Forage Plant Investigations.

The value of the hay crop in this country exceeds that of any other crop except corn. When we add the yield of pasture lands to that of hay fields, the total exceeds the value of even the corn crop. Investigations of grasses and forage crops are therefore of vital importance to American agriculture. The investigations in this line during the past year have shown that the maintenance of soil fertility is intimately associated with the production of forage crops and their proper utilization on the farm. Those States which are noted for the production of such crops not only have maintained the original fertility of the soil, but they spend for commercial fertilizers less than 1 per cent of the annual value of their crops, while those States which pay least attention to forage crops have impoverished the soil and spend annually for fertilizers from 5 to 9 per cent of the total value of their crops.

LEGUMINOUS FORAGE CROPS.

The influence of leguminous forage crops in restoring fertility to the soil is well known. No system of agriculture can be indefinitely maintained without some crops of this character. From the earliest

times clover has been the foundation of agriculture in our Northern States. But with each succeeding year the difficulty of securing a stand for this important crop increases, and there is a pressing demand for a suitable substitute for clover. The Department has undertaken to meet this demand by the introduction of alfalfa in the clover region. The success which has thus far attended our efforts in this direction is most encouraging. It has been demonstrated that alfalfa can be successfully grown in nearly all the Northern States. This work promises so much that we desire to push it vigorously during the coming year.

In our Southern States the cowpea is deservedly popular as a leguminous crop, both on account of its feeding value and its beneficial effect on the soil. But on account of its habit of growth this plant is difficult to harvest, either for hay or for seed. The Department has collected all known varieties of cowpeas in order to study the characteristics of each. We have undertaken to produce varieties that shall be free from the objectionable characteristics of those now grown, and have reason to hope for complete success. Other leguminous forage crops are being tested, both at Arlington Farm and at various places in the several States. Among these is a new and promising variety of alfalfa from South America that resists the rust which frequently attacks the common form, and which grows taller than the latter. As soon as seed of this variety can be obtained in quantity it will be distributed in those sections where there is most need of it.

GRASS GARDENS.

The grass garden on the Department grounds has been improved in a number of ways, and contains a large number of valuable grasses, legumes, etc. During the year this garden has been visited by a large number of people interested in agriculture, who have thus had an opportunity of observing many forage plants new to them. The public has shown a lively interest in this valuable display, which includes several valuable lawn grasses and ornamentals. An extensive grass garden was also maintained by this Department on the grounds of the Exposition at Charleston, S. C., and the correspondence received from Southern farmers relating to this garden shows that it was considered one of the most valuable features of our exhibit. It has been the means of introducing several new forage plants in the Southern States.

RANGE IMPROVEMENT.

The investigations in this branch of work have shown that the depleted Western ranges may be brought back to their original productiveness by proper methods of range management. Heretofore this work has been confined to small experimental areas. We have now progressed to the point where it becomes necessary to cooperate with

stockmen in the actual management of selected areas of range lands. To do this it is necessary that we control the grazing of stock on such areas. To this end I repeat my former recommendation, namely, that action be taken by Congress giving you, Mr. President, authority to secure for the experimental needs of this Department such tracts of public range lands as may be necessary for the best interests of the work.

SOIL AND SAND BINDERS.

Along the Atlantic and Pacific coasts and the shores of the Great Lakes, as well as in many inland places, there are to be found extensive areas of drifting sand. These shifting dunes of sand frequently destroy farms, cover up farm buildings, and interfere with the operation of railroads. The Department is engaged in investigations having in view the covering of these sand dunes with vegetation to prevent drifting. Several species of plants have been found that can be propagated rapidly in this drifting sand. Several successful plantations of these have been made, and others are now being made. Some of the leading sand-binding grasses are grown on an artificial sand dune in the grass garden on the Department grounds, forming a very instructive feature of our outdoor exhibit. From the results thus far secured in other countries we have reason to hope that we may finally bring these barren and dangerous sands into useful grass and wood lands.

CROPPING SYSTEM.

This Department is collecting data concerning the systems of farm crops used in various parts of the country, in order to study the relation of such systems to the maintenance of soil fertility. The data already at hand show that in those sections where a one-crop system prevails the soil rapidly loses fertility, and there is a large and increasing demand for commercial fertilizers, while in those sections where a system of rotation of crops prevails, particularly a rotation including forage crops to be fed on the farm, the soil continually improves, and commercial fertilizers are not used except on small areas for special crops. I believe that this Department can do much for agriculture in this country by devising suitable cropping systems for those sections where present systems are unsatisfactory, and giving the farmer information about the best methods of utilizing his crops.

HORTICULTURE.

EXPERIMENTAL GARDENS AND GROUNDS.

As pointed out in my last report, the Experimental Gardens and Grounds under the reorganization have been made exceedingly useful as an aid to other branches of work carried on by the Bureau of Plant Indus-

try and other Bureaus in the Department. With a view to still further increasing the value and efficacy of this work, investigations have been inaugurated having for their object the securing of information on crops which are cultivated more or less intensively in various parts of the United States. Special attention has been given to the cultivation of plants under glass and the elucidation of problems having a bearing on this important industry. The Experimental Garden is one of the oldest branches of the Department, and since this work was inaugurated a great many valuable plants have been accumulated. These have not been made as available for study as they might be, and for this reason plans have been put in operation whereby the various collections on the grounds and in the greenhouses will be brought together, properly labeled, and made useful for visitors and others who wish to study them.

A special feature of this work will be the development on the grounds of gardens of economic plants. It is planned to bring together a considerable number of the various native plants of the Eastern United States for the purpose of showing the possibilities of utilizing these plants in the simple decoration of the home and of schools. It is also planned to develop various collections of economic plants, such as drug and medicinal plants, and plants used in the arts and for numerous other purposes. As a further line of work for this branch of the Department, plans have been put in operation for securing and distributing seedling trees which have more or less historic interest. There are many historic trees in the vicinity of Washington and in the country at large, and it is believed that much good can be done toward arousing an interest in tree planting by distributing a limited number of these trees under proper direction. The seedlings, when grown, will be sent to schools in various parts of the country, and there will accompany each tree a concise statement setting forth the historic events connected with the tree itself and the growing of the seedling. The primary object is to keep alive patriotism and to encourage a love for nature and a love for home and the habit of tree planting.

THE ARLINGTON FARM.

The work on the Arlington Farm during the past year has been greatly increased. A considerable portion of the land has been drained, and during the year a thorough survey was made and the ground was platted, so that it was found practicable to begin the real work of experimentation. This farm, previous to its acquisition by the Department, was used for many years as a grazing area for horses and mules not in service, belonging to the War Department. In general it was fairly well covered with blue-grass sod, but many shrubs and trees had grown up to interfere with cultivation. The trees and shrubs were removed, the sod plowed and put into condition for the

reception of cowpeas or buckwheat, according to the condition of the area, and the work was completed. About 40 acres of the land which in 1901 were planted in cowpeas were this year devoted to plat work. The plats are uniformly one-twentieth of an acre in area. Some 4 acres of such plats are devoted to nursery purposes, including seedling forest trees, while the rest is given over to experiments with vegetables, plant-breeding experiments, experiments conducted by the Pathologist and Physiologist, Pomologist, etc. In surveying and platting the land the location of barns and future buildings was determined upon, and a barn suitable for important needs is being constructed at the present time. With the facilities at hand it will be practicable next season to inaugurate quite extensive work.

Tea Growing in the United States.

The work on the growing of American tea was continued during the year at Pinehurst, Summerville, S. C., in cooperation with Dr. Charles U. Shepard. Dr. Shepard now has at his place about 100 acres in tea gardens, and his factory is well equipped for carrying on work on a commercial scale and for accurate scientific experiments. With a view to bringing about a clear understanding as to the relationship of the Department to this work, a proper form of agreement has been prepared and entered into by the Department on the one hand and Dr. Shepard on the other. By the terms of this agreement the Department is able to secure the use of the extensive plant of Dr. Shepard for experimental purposes, and will profit by the results from the extensive work that he is carrying on. During the year careful attention has been given to methods of reducing the cost of the production of tea with very satisfactory results. Improved factory methods have also been put into operation, with the result that better grades of tea are now being turned out than ever before. To aid in this work, Dr. Shepard has secured during the year the assistance of an expert tea taster in New York, who has sampled his various grades and thus made it practicable to determine not only the kinds of teas which have proved of the highest quality, but the effects of different methods of picking and handling.

As pointed out in my last report, the yield of tea in Dr. Shepard's gardens last year was about 4,500 pounds, and this year there will be about 9,000 pounds of marketable tea. Some of the gardens have proved very prolific and profitable, while others have given very light yield of tea, having poor quality. All these facts, of course, will enable the Department to profit in further exploiting the work. With a view to increasing the interest in this crop, a tea farm will be established in Texas if suitable land and cooperation can be secured. Agents of the Department are now on the ground looking into the question, and the outlook is very favorable. Whether or not tea

growing in this country can be made a commercial success will depend, in large measure, upon most rigid attention to the details connected with the field and factory work. It is not expected that any large profits will be made, but it is believed that by proper and judicious management sufficient profit will result to encourage the planting of the crop in many parts of the South, especially where there is cheap labor available. Proper labor, of course, constitutes one of the most important factors in this matter; but, fortunately, there are many places in the South where hands now idle might be turned to some use in this direction.

Congressional Seed Distribution.

In my last report attention was called to the fact that the distribution of seeds was required by an act very specific in its terms, and that it was my wish to carry out the will of Congress in a way that would result in the most good to the country. During the year rapid advancement has been made in the matter of improving all of this work, and it is gratifying to announce that under the system which is being put into operation little or no friction has resulted. The Congressional distribution for 1901-2 was the largest in the history of the Department, yet notwithstanding this fact all the seed went out on time. With a view to increasing the value of the work, particular attention was given to the distribution of forage-crop seed, cotton seed, tobacco seed, and seed of other special crops. In each case an expert was put in charge of a particular crop and was responsible for securing new, rare, or little known varieties, and the distribution of each variety in a locality where it seemed likely that benefit would result from its use. Very encouraging reports have been received as a result of this work, especially in the matter of cotton distribution, where a special effort was put forth to secure new varieties or varieties which were known to have value locally, but which had not been generally distributed. With a view to still further increasing the efficiency of the seed work, a number of new plans have been put into operation during the year.

The method of securing seed through a contractor has been abandoned, as it was never satisfactory, offering opportunity for inferior service, and, besides, working a hardship on the seed trade of the country—something the Department has no desire to continue. Under the new system the Department secures its own seed in the open market, and contracts only for the purely mechanical features of the work, such as the packeting of the seed and the mailing of the same. With a view to making this work of more value to the country and encouraging the legitimate seed trade, plans have been inaugurated whereby the Department will gradually substitute new or little-known seeds, such as specialties or novelties, for the more common sorts here-

tofore distributed. Seedsmen are now cooperating with the Department in furnishing these specialties and novelties, and the Department will distribute them possibly only one year, dropping them then and allowing the demand, if demand there be, to be met by the regular trade. Particular attention will be given in all this work to the distribution of special crops, such as forage, tobacco, cotton, sugar beet, cereals, etc. In the handling of these special seeds and plants the work of the plant-breeding laboratories will be utilized, and the requirements of different sections of the country will receive careful consideration, so that crops will be selected to meet the needs and requirements of the districts into which they may be sent.

Foreign Seed and Plant Introduction.

During the year the Department pushed forward the lines of work on introduction of foreign seeds and plants as rapidly as the means at hand would permit. In carrying on this work the various branches of the Bureau have contributed to the expert knowledge to be applied to the best handling of the crops.

Agents have been sent to the Orient with a view to securing information on crops particularly adapted to the South. Rice has received special attention, and in addition the question of forage crops suitable for this region was also kept constantly in mind. An agent visited India, China, and Japan, and secured many valuable introductions in the way of seeds and plants which will be useful in building up new industries. This work has been greatly aided by the generosity of Hon. Barbour Lathrop, who, at his own expense, has carried on extensive agricultural explorations during the year, assisted by Mr. David G. Fairchild, an agricultural explorer of this Department. Mr. Lathrop has secured and forwarded to this country a number of valuable plants, which are being handled by the Department's agents and by private individuals, to whom such plants have been sent direct by Mr. Lathrop. Particular attention was given to the introduction of the bamboo, which it is believed will prove a promising crop in sections of the West and South, where this plant is hardy.

In former reports attention was called to the efforts of the Department in establishing date growing as an industry in this country. Considerable advance has been made in this direction during the past year, a large shipment of young date trees having been received from Mr. Lathrop. They were planted in the large cooperative date orchard established by the Department in Arizona. This orchard now comprises about 11 acres and contains 580 imported trees, besides 80 native seedlings. Another important introduction during the year through Mr. Lathrop's efforts is the Egyptian or berseem clover, which is very valuable for certain portions of the country as a soil reclaimer and enricher and as a forage plant. The continued fertility

of portions of the Nile Valley which are annually overflowed is largely due to the nitrogen-gathering properties of this plant.

Agents have also been sent to Algeria, Egypt, and other parts of Africa for the purpose of studying the irrigated crops of these regions, and also the crops which are particularly adapted to alkali soils. These agents have secured many valuable facts which will aid the Department in its extensive studies of the plants of our own arid and semiarid regions. With a view to securing additional forage crops and cereals from Russia and adjacent countries, an agent was sent to those regions in the early part of the year. The securing of forage crops, particularly the various kinds of Turkestan alfalfa, was the primary object of this visit; although some attention was given to obtaining varieties of fruits and cereals adapted to the dry regions of the Northwest.

MACARONI WHEAT.

The importance of the introduction and establishment of macaroni wheat in the United States, to which attention was directed in my last report, has been amply demonstrated by the results of the past year. We estimate that about 2,000,000 bushels have been harvested this season, but this will not meet the demand for it coming from all quarters. New mills are being built to grind it and old mills have been modified in order to handle it, and it now has its definite grade like other wheats in the Northwestern markets. It yields from one-third to one-half more than the other standard wheats in the same locality throughout the Great Plains region. Furthermore, it extends the wheat area much farther westward over districts of great extent, where it was not considered possible to grow wheat before, owing to light rainfall. The macaroni made from this wheat is pronounced by experts to be equal, if not superior, to the imported product, so that the success of this industry is assured.

INTRODUCTION OF WINTER WHEAT AND OTHER CROPS.

The results of the past year indicate that the winter wheats introduced and tested by the Department are likely to prove of as great, if not greater, value than the macaroni wheats. Four or five varieties obtained from east and south Russia are much more hardy than any varieties now grown in this country, and will extend the winter wheat area several hundred miles north and some distance farther west than at present. This means an increase of 5 to 10 bushels per acre over the standard spring wheats now grown in the same localities.

Quite valuable results have also been secured in the introduction of Swedish oats, proso or broom-corn millet, malakhof, sugar corn, and a number of other Russian crops. There has been rapid advancement during the year in the rice-growing industry, largely through the efforts of the Department in the introduction of new forms and the

obtaining of information from abroad bearing on the methods of handling the crop and preparing it for market. Particular improvement has been made in the rice-growing regions of Texas and Louisiana, where the work of the Department has yielded the most striking results. In former reports attention has been called to the great value of this work to the two States named, and such has been its development that at the present time the rice production in this country about equals the demand.

The Jordan almond is another successful introduction during the year. There are about 5,500,000 pounds of almonds grown in California, but many pounds are still imported from Spain for the reason that the California nut is not equal to the best imported kind, known as the Jordan. During the year buds and scions of this variety have been secured and sent to California, and it is certain that in a few years California-grown Jordan almonds will be on the market.

A special effort was put forth during the year to secure alkali-resistant crops, particularly alfalfas and cottons. Seed of the Turkestan alfalfa has been obtained and is now on the way to this country, and will be distributed, under proper direction, during the year. Seed, also, of a number of alkali-resistant cottons has been obtained in Algeria and Egypt, and steps are being taken to place these seeds where the conditions are such as to make their success a valuable adjunct to certain parts of our Western country.

PLANS FOR TESTING GARDENS.

As a means of further systematizing all of the work connected with the distribution of seeds and plants by the Department, and the introduction of the same from foreign countries, plans are being perfected for establishing in a number of places in the country testing gardens, which will enable the Department to work out a number of important problems connected with these investigations. It has been found by experience that the promiscuous dissemination of seeds, many of which are often of great value, does not give in all cases satisfactory results. It is highly important in all such cases to be able to determine definitely where such plants and seeds are likely to prove most successful. After this is known it is still necessary to convince farmers or fruit growers of the feasibility of growing the particular crop. Even then the work is not finished, for although the crop may be grown readily, the question of a market must be considered.

Suitable testing gardens, conducted possibly in cooperation with some of the experiment stations, but under the direct control of the Department, will be of great value in further continuation of this work. Such gardens may be used for the purpose of standardizing the various varieties of vegetables now being offered by the seedsmen throughout the country. There is at present a great deal of confusion regarding varieties of vegetables, and while the work of breeding is

growing apace it will be well worth while to fix the types of varieties and disseminate better strains of standard sorts. If the Department would set a high standard in this matter it would probably result in a great diminution of the indiscriminate renaming of varieties and in the introduction of such as are new only in some slight respect. It is obvious that work of this kind to be of the greatest value must be conducted under very careful conditions and be carried on in a sufficient number of regions to get results which will be of real value.

BUREAU OF FORESTRY.

On July 1, 1901, the Division of Forestry became a bureau. It has therefore completed its first year under the new form of organization. The results obtained have amply justified the change and the increased appropriation which accompanied it. Interest in forestry and a perception of its possibilities as the means of making productive a great national resource have developed so swiftly in the United States that the discrepancy between the capacity for public service of this branch of the Department of Agriculture and its opportunities was never so great as it is now.

During the past year the Bureau of Forestry has notably increased the store of knowledge on which all forestry depends, and has made large gains in introducing practical management of forests, both of public and private ownership. Its field work has engaged 162 men, and has been carried on in 42 States and Territories.

The forest work of the Department of Agriculture has hitherto proceeded as rapidly as the scanty means of forest education would supply men, and its growth has been normal and safe. In view of the greater product of the forest schools and the immensely growing demand upon its services it might hereafter safely increase its rate of progress. To check the growth of the Bureau of Forestry at this time will likewise check the spread of public sentiment in favor of forest protection. It will dull the desire of forest owners, applicants to the Bureau for assistance, some of whom have already waited for their turn until their patience is almost exhausted. It will dampen the willingness of young men of the right stamp to make forestry their profession, because they look forward with practical unanimity to the Government service. A single frost which would pass over a mature tree without effect will often injure and retard for years the growth of a healthy seedling. I conceive the Bureau of Forestry to be in precisely that situation.

Organization of the Bureau.

The work of the Bureau of Forestry is organized along four lines: Forest management, forest investigation, records, and tree planting.

Forest Management.

The Bureau of Forestry exists to secure the best management of the forests of the United States in the interests of the whole people. This involves not only the development of a science of American forestry, but also the general introduction of conservative methods in handling forests of private ownership.

The Division of Forestry offered in October, 1898, to give advice and assistance to forest owners desirous of introducing conservative management. The response to this offer was immediate, and has grown steadily in volume. During the last fiscal year 37 applications were received, asking advice for the management of nearly 2,000,000 acres of forest lands. Altogether the advice of the Bureau has been asked, since its offer in October, 1898, on 4,709,124 acres.

The working plans of the past year are in the nature of solutions of seven typical and widely differing forest problems. These problems are:

Management of a Southern Appalachian forest, containing a great variety of trees, mainly hardwoods, in a somewhat inaccessible region, where only the most valuable species can be lumbered at a profit and where special measures are necessary to assist their reproduction and to prevent the progressive deterioration of the forest as the best woods are cut out. Fire protection, at a cost which is not prohibitive from a business standpoint, forms one of the important questions involved. The tract studied has an area of 110,000 acres, and lies in Polk and Monroe counties, Tenn.

Management, in conjunction with coal mining, of a tract of mixed softwoods and hardwoods, containing 50,000 acres, in Scott, Campbell, and Anderson counties, Tenn. Silviculture, contract lumbering, transportation, and protection from fire are the more important points studied.

Management of 60,000 acres in Beaufort and Hampton counties, S. C., on which the most important commercial species is Longleaf Pine. Fire, lumbering, and turpentine orcharding have seriously injured the forest, and the consideration of first importance is a method of treatment which shall restore it to full productiveness while yielding a fair return on the value of the land. The conditions are typical of much of the Southern Pine Belt.

Management of 10,000 acres of fine hardwoods on Grand Island, Michigan, with an accessible market, a high price obtainable for the product, and consequently an exceptionally good opportunity for paying forestry.

Management of 15,000 acres in Herkimer County, N. Y., composed equally of cut-over and virgin forest. The most important timber tree is here, as generally in the Adirondack region, Red Spruce,

and the chief object of the working plan was to provide for the reproduction of this species and to suggest such changes in present methods of lumbering as will give immediate and good returns from the forest and at the same time will insure a profitable future yield.

A somewhat similar problem, but in a different locality, was that presented by a tract of 275,000 acres in northwestern Maine. Field work was completed during the year on 150,000 acres of this tract, timbered mainly with Red Spruce and Balsam, of which the former, as commercially the more valuable of the two, should be favored as the source of subsequent crops.

The last tract on which field work was completed during the year was one of 15,000 acres near Arden, N. Y. The forest consists of second-growth hardwood and is for the most part in poor condition. The working plan advises a system of thinnings by which the condition of the forest will be improved and which will at the same time yield good returns in firewood.

The total forest area now under management in accordance with working plans prepared by the Bureau of Forestry is 372,463 acres. Material for a number of new working plans is now being gathered. Especially notable is the plan in preparation for a tract in southeastern Texas which comprises an area of 1,250,000 acres and is the largest private holding of timber land in the United States.

By request of the Secretary of the Interior for advice in the management of the national forest reserves, which now include 60,162,525 acres, the Bureau of Forestry became the official adviser for these reserves in matters of forest policy. The making of working plans for the reserves has continued during the year. Field studies have been carried on in the Prescott, the Priest River, and the Big Horn reserves, and a preliminary examination was made of the San Francisco Mountains Reserve. A similar request from the Secretary of War, made during the last fiscal year, has placed the Bureau in the same relation toward the military wood and timber reservations, eight in number, with an area of 117,468 acres. Of these, that at West Point, containing 2,080 acres, has been examined, and a working plan for its management will soon be prepared.

In accordance with the request of the Secretary of the Interior, an examination has been made of the forest lands within the Lac Court d'Oreilles, the Bad River, and the Menominee Indian reservations, in Wisconsin, in order to recommend measures for the conservative lumbering of the timber they contain.

Forest Investigation.

The studies of commercial trees made during the past year include White Pine, Red Pine, White Oak, Scarlet Oak, Red Oak, and Aspen.

in Michigan; Sugar Pine in California; Balsam in Maine; White Oak and Chestnut Oak in Tennessee, Kentucky, and Missouri; Western Yellow Pine in Arizona, and Lodgepole Pine in Wyoming and Montana. Previous studies of the Longleaf and Loblolly pines, of the Sierra Big Tree of California, and of the Bristle-cone Fir in southern California were completed and reports prepared on Western Hemlock and the Pacific Coast Redwood.

Studies of the growth and possibilities of New England second-growth hardwoods were carried on, and an investigation was begun of the distribution and the conditions necessary to the best development of the trees comprising the eastern Missouri and Arkansas swamp forests.

Studies of the forest and its industrial relations were made in the States of Michigan, Kentucky, Ohio, Texas, New Mexico, Arizona, South Dakota, Wyoming, Montana, California, and Iowa. Some of the questions involved were the present and future timber supply, forest fires, and the relation of the forest to stream flow, irrigation, and grazing.

Descriptive studies were conducted in cooperation with the United States Geological Survey of about 3,000,000 acres of the Sierra Forest Reserve and of the region in the Southern Appalachians, within which it is proposed to establish a national forest reserve.

In cooperation with the Bureau of Chemistry, investigations have been undertaken of native tan extracts and their comparative values in tanning, of Philippine gum products, and of possible additions to the present list of native woods suitable for the production of paper pulp.

A cooperative study of insects which injure the forest was begun with the Division of Entomology.

It is highly gratifying that the efforts which the Bureau has been making to discover a less injurious method of turpentine orcharding than that hitherto employed, and to which I made reference in my last report, have been successful, and that the way is apparently open for the general introduction of an improved method which will be of notable value in maintaining the source of the turpentine industry.

Tests of the durability of treated and untreated construction timber and railroad ties have been continued, in cooperation with the Bureau of Plant Industry. The enthusiastic assistance which has been received from railroad companies has demonstrated their appreciation of this valuable work.

In cooperation with the Bureau of Chemistry, and as the result of a widespread and urgent demand, the Bureau of Forestry has taken up the series of tests to determine the strength of the principal merchantable timbers of the United States, which were discontinued in 1896.

Records.

The enlargement of the Bureau's quarters, which took place during the year, made possible for the first time the proper equipment of a library and the transference thither of the entire collection of forest literature from the Department library. This has given the Bureau a large, easily accessible working and reference library. The photographic collection now numbers over 6,000 prints, and a well-equipped photographic laboratory has been installed.

Tree Planting.

The work of the Bureau in tree planting for the last year has been chiefly notable in the conspicuous progress made in extending cooperative planting, in the creation of the first reserves for forest planting on Government lands in a region that is now unproductive of timber, and in the successful initiation of measures to control, by means of planted forests, the shifting sand dunes on both the Atlantic and the Pacific coasts.

In tree planting as in forest management the Bureau has sought, as the only method by which the desired end could be attained on a broad scale, to enlist the interest of the private landowner. Circular No. 22, issued July 8, 1899, offers cooperation in the work of planting forests similar to that previously made for forest management. Up to the close of the last fiscal year 262 applications for assistance had been received, nearly 200,000 acres had been examined, and 224 planting plans, covering about 6,400 acres, had been made. Of these, 51 plans for about 3,400 acres were made during the past fiscal year, and 83,597 acres were examined.

These figures, however, by no means cover the actual accomplishment of the Bureau in introducing forest plantations on private lands. The plans made are for 172 localities, in 29 States and Territories. Not only does the example set by each plantation made affect the whole neighborhood, but there has also been in many cases a public agitation of the question of tree planting, with local meetings addressed by the agents of the Bureau. Extensive planting on other land than that for which plans were made has frequently followed. Plantations of this kind will be of very considerable economic value in many States of the Middle West by furnishing local supplies of firewood, fencing, telegraph poles, and railroad ties, besides providing wind-breaks and other protection.

The success of economic tree planting in many scantily timbered or treeless regions of the Middle West is now assured. This means enhanced prosperity for these regions. A local timber supply is a matter of decided importance to the farmer, who needs cheap fuel and fencing. As a result of the Bureau's work, thriving plantations now

exist in the Dakotas, Nebraska, Kansas, and Oklahoma, as well as in the older States of Iowa, Illinois, and Indiana.

In New England particular attention has been given to the possibility of profitably planting cheap land with white pine. The supply of this highly useful timber tree has been greatly diminished in the Eastern States. If it can be brought back as a paying forest tree under management, the benefit will be one in which both the landowner and the timber-consuming public will share. So encouraging has been the outcome of the examination of this question by the Bureau that many owners of denuded lands are restocking them with white pine.

The Proposed Appalachian Forest Reserve.

In my report on the Forests and Forest Conditions of the Southern Appalachian Mountain region, which has been printed along with your message to Congress on this subject, of December 19, 1901, I discussed briefly the rapid rate at which the forests on these mountain slopes were being removed, and the extent to which the resulting floods were destroying agricultural lands and other property along the streams rising in that region. In that report I stated that the damages resulting from these floods during the year (1901) "approximated $10,000,000, a sum sufficient to purchase the entire area recommended for the proposed reserve."

Subsequent examinations have shown that during the few months following the date of that report the flood damages on these streams, extending across eight different States, aggregated $8,000,000, making a total of $18,000,000 during the twelve months ending in April, 1902. These examinations also show, as additional results of the deforestation of these mountain slopes, (1) that the water powers along these streams, which have an aggregate annual value of $20,000,000 as a basis for manufacturing enterprises, are being gradually but certainly destroyed through the increasing irregularity in the flow of the streams; (2) that the soils which are being washed down from these mountain slopes are rendering annually less navigable the Ohio, the Tennessee, the Mississippi, and other rivers of these Southeastern States; and (3) that the rate of land erosion on these mountain slopes from which the forest cover has been removed is now as great in a single year as it was during ten centuries while these slopes were covered with primeval forests.

A bill providing for the establishment of the forest reserve recommended in my report is now pending before Congress. With an increased realization of the importance of this measure I reproduce here the concluding paragraph of that report:

> The preservation of the forests, of the streams, and of the agricultural interests here described can be successfully accomplished only by the purchase and creation of a national forest reserve. The States of the southern Appalachian region own little or no land, and their revenues are inadequate to carry out this plan. Federal action is obviously necessary, is fully justified by reasons of public necessity, and may be expected to have most fortunate results.

BUREAU OF SOILS.

The organization and work of the Bureau of Soils has been essentially along the same lines as heretofore, with the addition of an important line of work in the division of soil management. Attention has been given, as heretofore, to the administrative work, the soil survey, the tobacco investigations, drainage investigations, and the laboratories maintained in support of these several lines of field work. The wisdom of Congressional action in converting the Division into a Bureau and increasing the appropriation has been shown in the amount of work done and in the appreciation of this work from various sources. The soil survey, particularly, has been greatly extended, and the division of soil management, although merely started during the year, gives promise of some more important results than have been achieved in soil investigations for some time past. Prof. Franklin H. King, formerly professor of agricultural physics at the University of Wisconsin, has taken charge of this line of field work. He is considered peculiarly fitted for this place, and his appointment has been very generally commended.

During the year Mr. M. L. Floyd, the tobacco expert who had done so much to make successful the tobacco investigations of the Bureau, severed his connection with the Department to become general manager of a tobacco corporation organized to grow the shaded Sumatra tobacco in Connecticut, an industry established by this Department. In his new position Mr. Floyd receives far greater remuneration for his services than the Department could afford to pay, in view of the salaries paid to others by the Government.

The interest in the work of the Bureau of Soils is growing, and the demands for work in different parts of the country are increasing, as evidenced by the liberality of Congress in enlarging the appropriation and by the many requests received for the extension of the different lines of investigations. The Bureau of Soils now has a force of over 100 persons, 75 of whom have had a scientific training. It is believed that the results of the work in showing the conditions and resources of the soils of the country and in giving the people precise and accurate knowledge regarding the possibilities of the soils justifies fully every expenditure that has been made and every recommendation that will be made for the further extension of the work. With the fierce competition for commercial supremacy now operating, every particle of information bearing upon the natural resources of the country which will in any way tend to increase the production of our present crops or to develop new methods or build up new industries is of the utmost value, especially if, as in this case, the people are inspired with sufficient confidence to heed the advice of the Department and to take advantage of its work.

Cooperation with State Institutions.

During the year this Bureau has cooperated, as far as possible, with State institutions, including experiment stations, boards of agriculture, and geological surveys; also with Bureaus and Divisions of this Department, as well as with other Departments of the Government. Such cooperation has been particularly close with the North Carolina department of agriculture and with the Illinois experiment station, both of which institutions have contributed money toward the expenses of the soil survey in their respective States. In other States the cooperation has been just as cordial, but the institutions have not been able to render financial assistance. Their advice has been sought and given wherever possible in arranging for and in the carrying on of the work, and the work has been done, as far as possible, with the ultimate object of being of service to the State institutions in the prosecution of more detailed work. The Utah experiment station has cooperated in the line of drainage investigations and has contributed valuable assistance and advice in the work that has been started at Salt Lake City. The Connecticut experiment station and the Pennsylvania experiment station have continued their cooperation in the tobacco investigations with credit and profit to all of the institutions concerned.

The Bureau of Soils, through its laboratories, its soil survey, and its other lines of investigation, has cooperated with and has helped other Bureaus and Divisions in the Department, and has cooperated with the War Department in furnishing an assistant to organize a soil survey in the Philippine Islands, and in furnishing assistants to inspect the soils of some of the military posts and to advise as to the treatment in the establishment of parade grounds, a matter which is of considerable importance, involving the expenditure of large sums of money where the natural soils are not suited to the formation of a permanent sod.

Progress and Cost of the Soil Survey.

The area surveyed and mapped during the fiscal year was 14,541 square miles, or 9,306,240 acres, and the area previously reported as having been surveyed was 8,082 square miles, making a total of 22,623 square miles, or 14,478,720 acres. This work was carried on during the year in twenty-five States and Territories and in Porto Rico.

The following table shows the total area surveyed during the fiscal year 1902, together with that previously reported, in each of the thirty States and Territories in which the soil survey work has been carried on. This work has been uniformly done on a scale of 1 inch to the mile, and the maps have been published or are ready for publication. This table does not include any areas in which work of reconnoissance merely has been done, but only areas in which actual soil surveys have been made and soil maps prepared.

Areas surveyed and mapped during fiscal year ended June 30, 1902, and the areas previously reported.

State or Territory.	Work during 1902.	Work previously reported.	Total.	
	Sq. miles.	*Sq. miles.*	*Sq. miles.*	*Acres.*
Arizona	95	400	495	316,800
California	753	1,401	2,154	1,378,560
Colorado	150		150	96,000
Connecticut		245	245	156,800
Georgia	571		571	365,440
Idaho	399		399	255,360
Illinois	1,359		1,359	869,760
Iowa	432		432	276,480
Kansas	461		461	295,040
Kentucky	330		330	211,200
Louisiana	202		202	129,280
Maryland	418	1,762	2,180	1,395,200
Massachusetts		155	155	99,200
Michigan	828		828	529,920
Mississippi	666		666	426,240
Missouri	168		168	107,520
Montana	105		105	67,200
New Jersey	908		908	581,120
New Mexico		100	100	64,000
New York	490		490	313,600
North Carolina	1,625	1,800	3,425	2,192,000
Ohio	500	480	980	627,200
Pennsylvania	519	420	939	600,960
Porto Rico	330		330	211,200
South Carolina	686		686	439,040
Tennessee	547		547	350,080
Texas	495		495	316,800
Utah		768	768	491,520
Virginia	1,354	250	1,604	1,026,560
Washington	150	301	451	288,640
Total	14,541	8,082	22,623	14,478,720

The following table shows the area surveyed and mapped and the cost of the work during the fiscal year ended June 30, 1902:

Areas surveyed and mapped and cost of the field work during fiscal year ended June 30, 1902.[a]

State or Territory.	District.	Area surveyed.	Cost per square mile.	Total cost.
		Sq. miles.	*Dollars.*	*Dollars.*
Arizona	Yuma area	95	4.61	437.95
California	Imperial area	169	3.17	535.73
Do	Salinas Valley	344	3.42	1,176.48
Do	Ventura area	240	3.77	901.80
Colorado	Rockyford area	150	4.73	709.50
Georgia	Cobb County	346	1.44	498.24
Do	Covington area	225	.71	159.75

[a] This includes the salaries of the men while in the area and their subsistence expenses, but not the cost of transportation to and from the area.

Areas surveyed and mapped and cost of the field work during fiscal year ended June 30, 1902—Continued.

State or Territory.	District.	Area surveyed.	Cost per square mile.	Total cost.
		Sq. miles.	*Dollars.*	*Dollars.*
Idaho	Boise area	399	1.81	722.19
Illinois	Clinton County	494	.88	[a] 434.72
Do	St. Clair County	215	1.15	[a] 247.25
Do	Tazewell County	650	1.39	[a] 903.50
Iowa	Dubuque area	432	.94	406.08
Kansas	Wichita area	461	1.94	894.34
Kentucky	Union County	330	2.20	726.00
Louisiana	Lake Charles area	202	3.71	749.42
Maryland	Harford County	418	1.48	618.64
Michigan	Allegan County	828	1.44	1,192.32
Mississippi	Yazoo area	656	2.24	1,489.96
Missouri	Howell County	168	1.14	191.52
Montana	Billings area	105	4.96	520.80
New Jersey	Salem area	493	1.42	700.06
Do	Trenton area	415	2.23	925.45
New York	Westfield area	260	2.89	751.40
Do	Elmira area	230	2.03	466.90
North Carolina	Alamance County	365	1.32	[b] 482.80
Do	Carey area	63	3.11	[b] 195.93
Do	Craven area	697	.96	[b] 669.12
Do	Hickory area	500	1.01	[b] 505.00
Ohio	Columbus area	338	1.34	452.92
Do	Toledo area	162	.95	153.90
Pennsylvania	Lebanon area	[c] 519	1.48	768.12
Porto Rico	Arecibo to Ponce	330	5.02	[d] 1,655.55
South Carolina	Abbeville area	686	1.01	692.86
Tennessee	Montgomery County	547	1.68	918.96
Texas	Alvin area	280	2.45	686.00
Do	Willis area	215	2.70	580.50
Virginia	Bedford area	[c] 382	2.11	806.02
Do	Harrisonburg area	542	1.44	780.48
Do	Prince Edward area	430	1.32	567.60
Washington	Walla Walla area	150	1.82	273.00
		14,541	1.83	26,551.76

[a] Of these amounts, $624.95 was spent by the Illinois experiment station.
[b] Of these amounts, $914.20 was paid by North Carolina department of agriculture.
[c] The portions of these areas surveyed in the previous fiscal year were given in the last report.
[d] Of this amount, $300 was paid by the Porto Rico experiment station.

RECAPITULATION.

Cost of field work	$26,551.76
Supplies	858.84
Railroad transportation	2,766.28
Preparation of reports	12,870.17
Total cost of soil survey	43,047.05
Paid by State organizations	1,839.15
Paid by Department of Agriculture	41,207.90
Area surveyed ... square miles	14,541
Cost of work in field ... per square mile	$1.83
Preparation of reports ... do	.88
Transportation and supplies ... do	.25
Average cost ... do	2.96
Average cost to Department of Agriculture ... do	2.81

It will be noticed that the cost of the work per square mile varies from 71 cents in the Covington area, Georgia, to $5.02 for the work in Porto Rico. The average cost has been $1.83 per square mile, as against $2 per square mile during the preceding fiscal year. The area covered is over two and one-half times as large, and the work has cost 17 cents per square mile less than last year. The variation in the cost per square mile is due in part to the character of the country, the condition of the roads and of the weather, the complexity of the soils, the presence and character of alkali in the Western areas, and the accuracy of the base maps used. The average cost to the Department of Agriculture of the work complete, including supplies and railroad transportation, the preparation of reports, and the salaries of the men during the three winter months, when the field work has practically to be suspended, has been $2.81 per square mile, as against $3.26 per square mile last year, a saving of 45 cents per square mile. This saving is due not only to the greater efficiency of the field parties by reason of their better training, but also to the longer average length of the field season for each party, which has been accomplished by moving the parties from place to place as the season advances. It has been found possible to keep some of the parties out during the winter in Arizona and southern California, and to shift parties working in the Northern States during the summer months to the Southern States during the fall. In this way the average length of the field season has been something over nine months per party, and it is believed that this can be considerably increased, although it is advisable to have each party spend some time at headquarters, not only for the final revision of their reports and maps, but to get acquainted with the office and laboratory work and to keep in close touch with the objects and purpose of the soil survey.

THE FIELD FORCE.

The organization of the field force has been carried to a very high state of efficiency. Administratively the very greatest of care and attention to details is given, and the low cost per square mile shown in the preceding statements is due in a large measure to the judicious and economical management of the force. The salaries of the soil experts employed by the Bureau are low as compared with those paid in other branches of scientific work. The average expense of a party of two men in the field for subsistence and the hire of a team averages about $120 per month, or $1,080 for the field season of nine months. The parties are equipped with the most modern instruments for the classification and survey of soils, and it has been possible to furnish them with such explicit instructions as to the character of their work, the subjects they are to investigate, and the subjects which are to be discussed in their report upon the area that they know exactly

what is to be done on entering a given area and can proceed with their work with the minimum of time for preliminary investigations or reconnoissances. They are required to report to the central office at least once each week, noting the area surveyed, the new soil types established, and the character of their work, and to send in from time to time sections of their map for criticism and suggestion as the work proceeds. It is required that each party shall complete the map in all details and write up the report in final shape before leaving the area. These reports are then typewritten, and a copy returned to the field party for correction or for additions or changes. The work of each party is thoroughly inspected, so far as this has been possible, in order to correlate the new soil types with those already established, and to confer with the men as to suggestions which can be safely made of new methods of cultivation or of new industries which may be established. As the work of the soil survey assumes greater proportions this inspection work becomes more and more necessary and more valuable, and it is advisable that a regular inspection force should be established for the several districts into which the country may be divided.

The scale upon which the soil maps are published enables tracts as small as 10 acres to be represented, and while there must always be some variation allowed in each type, as it would be confusing to show too much detail on the maps, still, where a type is represented by even a small tract of 8 or 10 acres, it is shown upon the soil map, so that landowners may rely upon an accurate classification of their soils according to the types established.

The reports describe in all necessary detail the characteristics of the soils and their important variations; the history of the settlement and agricultural development of the area: the climate, physiography, and geology; the agricultural methods in use and the agricultural conditions in the area, such as the tenure and size of the farms, the efficiency of labor, the principal products, and transportation and market facilities, together with such special problems as may be encountered, such as hardpan, acidity, irrigation, seepage waters and drainage, alkali, and the reclamation of swamp or worn-out lands or alkali soils, as these all have their bearing upon the commercial use and value of the soils.

RELATION OF THE SOIL SURVEY WORK TO THE EXPERIMENT STATIONS.

With the increasing interest in the soil investigations and the economic value which the results have shown in a number of cases, the experiment stations are taking a lively interest in this work, and it seems proper to mention the true relation which should be established between them and the Department in the further prosecution of the work. It seems advisable that the management of the soil survey

should be vested in the Department of Agriculture. This insures continuity in the work and uniform classification of soils; also the benefit of experience in other localities in advising as to the commercial possibilities and value of the introduction of new methods of culture and of new crops and industries. It is advisable that the experiment stations and other State institutions should cooperate in this work to the extent of furnishing assistants or financial aid, as this insures an intimate knowledge of the conditions of the area to the State organization, as well as a larger amount of work within the borders of the State. In many cases, if such financial assistance be given, one or more parties can be assigned for continuous work in a State where, if the expenses were all borne by the Bureau of Soils, a party could be assigned for only a portion of the season. Various State organizations have contributed $1,839.15 toward the field expenses of the soil survey during the past year.

These soil surveys are in the nature of a general reconnoissance of the area. They show the conditions which prevail, and the maps show the character and distribution of the soils. This is, however, merely a basis for further work, and it is necessary in many cases that the information thus furnished and the suggestions which are made should be followed by further investigations and practical demonstrations of the efficiency and commercial value of the suggestions in order to insure their successful adoption by the residents of the area. Farmers are proverbially ultraconservative as to their methods, and are usually, and often justifiably, very unwilling to accept advice unless it can be shown that improvement will surely follow. Such demonstration work can, in most cases, be better accomplished by the stations than by the Department of Agriculture, for the station forces have a more intimate knowledge of the conditions and of the people, and are, as a rule, in closer touch with the people than is the Department, and with these reports and maps they have the basis for further work in the improvement of the agricultural conditions of the area, upon which they can expend their full energy and all the resources at their command. If the soil-survey work is not followed up on these practical lines, much of the efficiency and value of the work will surely be lost.

As pointed out in my last report, the experience of the men engaged in this work is likely to be invaluable, not only to them, but to the country as well. Spending, as they do, from three to nine months in an area, making a critical study of the soils, crops, methods of cultivation, and market and transportation facilities, and bringing together this experience from all sections, the men have unusual opportunities for securing a wide knowledge of the agricultural industry of the country and its resources. This is training up a class of men fitted to observe and appreciate resources and advantages that should be of

great value in the further development of the agricultural interests of the United States as the country becomes more thickly settled and the strife for commercial supremacy becomes greater. As these men become riper in experience and judgment and have a fuller knowledge of the agriculture of the country, they will doubtless be called to positions of trust and responsibility in State organizations and in commercial enterprises in which their experience and ability will be invaluable. This is and should be one of the important functions of the Department, and the influence of the Department will be felt more and more throughout the country as these men are called to such positions.

PAST AND PROPOSED WORK OF THE BUREAU OF SOILS.

The statements following show the results that have been accomplished during the past year and the work that is proposed during the present and the next fiscal year in each of the States. This is of course subject to change as to details as the time approaches for the actual prosecution of the work. It is given as the basis for the continuation and extension of the work.

ALABAMA.

No work has been done in this State during the past fiscal year, but it is proposed this fall to make a soil survey of Perry County, which lies partly in the black calcareous prairie belt and partly in the sand region. Two parties will be assigned to this area in October, with the expectation that the whole of the county can be surveyed during the present field season. On the completion of this work both parties will be transferred to Mobile County to make a soil survey of that area, particularly in the interest of the truck growers, and to investigate the adaptation of the soils to tobacco. After this it is contemplated to make a soil survey in Marshall County in the interest of the fruit and tobacco growers, and to survey Lauderdale County, if possible. In all, it would be advisable to spend nine months in Alabama during the next field season.

ARIZONA.

During the past field season a soil survey was made of the area below Yuma, where the waters of the Colorado River are taken out for irrigation. The whole area covers about 95 square miles, although only a portion of it is at present under ditch. A considerable part of this area is subject to overflow during flood times in the Colorado River, and schemes have been proposed for dikes and levees to prevent this overflow, which, if carried out, will add a considerable area of valuable land to the irrigated district. This tract, with its tropical climate and fertile soils, has been compared to the delta of the Nile, and it is the

intention of the Department, through its soil survey and through the work of the Bureau of Plant Industry, to see if crops equally as valuable as those cultivated along the Nile and adapted to this tropical climate can not be introduced.

This party was in charge of Mr. J. Garnett Holmes, who has had considerable experience in soil survey work in other parts of Arizona and in southern California.

It is believed that the information obtained in this work will be the basis of most valuable economic development in the introduction of crops from Algeria and Egypt. There is quite a variety of soils of different character in this area, and while there is considerable trouble with alkali it is believed that this problem can be easily controlled and that the locality will develop into one of the important irrigated districts of the West.

It seems advisable to spend three months in a soil survey of the upper Gila Valley around Solomonville during the next field season.

ARKANSAS.

No soil surveys have been made in this State during the past fiscal year, but a party is at present in the State, making a survey around Stuttgart. It is impossible at this time to make any statement as to the economic results of this work.

CALIFORNIA.

Soil surveys have been carried on in three areas during the fiscal year, namely, around Imperial in the Colorado Desert, in the Salinas Valley, and in the Ventura area.

The work in the Salinas Valley was undertaken particularly in the interest of the sugar-beet growers. This was formerly a great wheat area, but in recent years the yield of wheat has fallen almost below the point of profitable production and barley has taken its place to a considerable extent. The rainfall, however, is so variable that crops are uncertain without irrigation, and irrigation systems are now being planned, particularly for the sugar-beet industry, which has developed to large proportions.

This party was in charge of Mr. Macy H. Lapham, and the area surveyed covered 344 square miles. Eleven different types of soils were recognized and their relation to the various crops determined. The relation of these soils to crops had been recognized to a certain extent, but the orderly classification of the soils can not fail to be of value in the future development of the agriculture of the area, especially as the industry is at present changing and developing along new lines.

All of the soils capable of cultivation in Ventura County were surveyed by a party under the charge of Mr. Holmes, the area aggregating 240 square miles. There are several valleys where irrigation is

practiced, the most extensive being the valley of the Santa Clara River. Over a large part of the area, however, crops are grown without irrigation, the principal crops being lima beans, sugar beets, and barley.

The soils of the upper part of the Santa Clara Valley are generally well drained and free from alkali. Extensive areas of the delta lands, including some of the most fertile soils of the county, are deficient in drainage, and the alkali problem is becoming more and more serious. As a result of the survey, and from experiments that have been made at the suggestion of the Bureau, it is evident that the alkali problem can be economically and efficiently controlled. Thirteen types of soils were recognized in this area and their relation to crops reported upon.

From the results attained in the irrigation of the area below Yuma, and from the exceedingly arid climate, it was believed that the Colorado Desert afforded exceptional facilities for the introduction of certain tropical plants, as well as for Egyptian cotton and other products successfully grown in Egypt and on the Algerian Desert. In furtherance of this idea, a company was organized under the laws of Mexico to construct a canal through Mexican territory and deliver water from the Colorado River to a point near Calexico, on the border line between this country and Mexico, to a company chartered under the laws of the United States to distribute the water to settlers in the Colorado Desert. The land was taken up under the homestead and desert-land laws and water rights purchased from this company for the irrigation of the lands. It was realized that it was very desirable, as this enterprise was starting, to make a soil survey in order to classify the soils and determine their alkali content and their relation to crops. Accordingly, Messrs. Means and Holmes were assigned to this work, and an area of 169 square miles was surveyed around Calexico and Imperial.

This country lies at or somewhat below sea level, the Salton Sink, the lowest portion of the desert, being about 270 feet below sea level. Five distinct types of soil were recognized in this area, ranging from a loose, incoherent dunesand to a very impervious clay, and including a sand, a sandy loam, and a loam. The area is everywhere underlain with a stiff, impervious clay containing alkali. The Imperial clay is difficult to cultivate, and water penetrates it very slowly. Large areas of alkali lands were encountered, and it is estimated that about 54 per cent of the area has more than 0.4 per cent alkali as an average for 6 feet in depth. There are serious problems, therefore, to be encountered in the successful development of agriculture in the area. It is believed that about 50 per cent of the area can at present be cultivated in nearly all crops adapted to the locality, while a considerable portion of the remainder may be reclaimed by drainage, or can be used for alkali-resistant crops.

The importance and necessity of having this knowledge of the soil conditions has been recognized, and very urgent requests have been received for an extension of the soil-survey work to embrace practically all of the lands in the Colorado Desert which can be irrigated, as a basis for the intelligent cultivation of this area, and to insure, as far as possible, the successful settlement of the country. Recognizing the importance of this work, it is proposed to combine a number of our field parties and place them in the area during the coming fall and winter to make a soil survey of about 1,500 square miles of the Colorado Desert, so that settlers may know the actual character of the soils which they purchase, and that industries can be established on the soils best adapted to them.

In addition to this work it is proposed to extend the soil survey to the Santa Clara Valley in the interest of sugar-beet, grain, and stock production, and to take up the San Bernardino Valley in southern California, which is the last of the great fruit areas in southern California that remains to be surveyed. It is believed that very valuable results will be attained by the soil survey when it is extended to the sugar-beet area around Chino and the fruit areas of Pomona, Riverside, San Bernardino, and neighboring towns.

In all it appears desirable to spend twenty-one months, on the basis of one party, in the State of California during the next field season, and it is believed that the importance of the areas to be investigated fully justifies the time and attention to be given to the work.

COLORADO.

During the present field season a soil survey is being made, under the charge of Mr. Macy H. Lapham, of the irrigable lands of the Arkansas Valley between Rockyford and the Kansas State line. There will be nearly 1,000 square miles of intricate soil mapping, with alkali problems to be worked out, but it is believed that by concentrating some of the northern parties in this area during the fall the whole area can be surveyed. This work is undertaken principally in the interest of the sugar-beet growers and of the melon and truck growers. Not only is it desirable to understand better the relation of the soils to crops, but with the extension of irrigation systems the natural drainage is found to be deficient and alkali is rising and threatening trouble and losses. The work has progressed far enough to indicate that the alkali problem can be economically and efficiently controlled, and it is believed that the classification of the soils will give a basis for the most profitable development of the sugar-beet and truck interests of the area.

It appears desirable to spend about six months during the next field season in a survey of the San Luis Valley, where the alkali problem is becoming far more serious even than in the Arkansas Valley.

CONNECTICUT.

No extension of the soil survey has been made in the Connecticut Valley since 1899, but with the extension of the profitable industry of producing the shade-grown Sumatra tobacco there is a very strong demand now that the survey should be extended to include many smaller valleys on either side of the area surveyed in 1899, and it is proposed to spend about three months in the State during the next field season, to give a basis for the extension of the tobacco industry on either side of the main valley.

DELAWARE.

No surveys have been made as yet in Delaware, and none is contemplated during the present year. There is, however, a demand for a soil survey to extend over the entire State, and it seems desirable to spend three months in the State during the next fiscal year in such work.

FLORIDA.

No surveys have been made in this State up to the present time, but it is proposed, if suitable arrangements can be made for a base map, to make a soil survey in Gadsden County in the interest of the tobacco growers.

GEORGIA.

During the past fiscal year two areas were surveyed in Georgia, including Cobb County and an area around Covington, the former being under the charge of Mr. R. T. Avon Burke and the latter of Mr. Herbert W. Marean.

It was hoped that the survey in Cobb County would show the possibilities of fruit raising, but it is believed that the prospects for this industry are not so favorable in this locality as they are farther north, and it is therefore proposed to extend the survey to include the northern half of the Ellijay sheet of the United States Geological Survey to include portions of Union, Gilmer, and Fannin counties in the interest of the fruit growers and as an extension of the survey in the mountain areas in Virginia and North Carolina. It is intended to give about six months to this work during the next field season, and it is also proposed to survey an area in Decatur County in the interest of the tobacco growers.

HAWAII.

No soil survey has been made in this Territory as yet, but there have been strong demands for the work, and a recommendation will be made for needed legislation to permit the Department to extend its soil survey work to that Territory at an early date.

IDAHO.

A soil survey party, under the direction of Mr. C. A. Jensen, has completed a survey of the Boise area, extending from Boise City to a point some distance west of Caldwell and including the principal irrigated lands of that section. Serious problems were encountered in this area in the occurrence of hardpan in the soils, and there were other soil problems upon which advice was given which it is believed will be of material economic value in the agricultural development of the area, which is assuming considerable importance.

A party, in charge of Mr. Louis Mesmer, has been assigned to survey the area between Lewiston and Moscow. The wheat yields in this area have declined, and the people are anxious to introduce forage crops, and the soil survey work is to be used as a basis for the consideration of this problem.

Representations have been made to the Department which make it appear advisable to spend about six months in the next field season in the survey of the irrigated lands of the Blackfoot area.

ILLINOIS.

Through cooperation with the Illinois experiment station the Bureau was enabled to put two parties in the field during the early part of the present field season, and at the close of the fiscal year had made a soil survey of Tazewell and Clinton counties, under the direction of Mr. Jay A. Bonsteel, and a portion of St. Clair County, under the direction of Mr. George N. Coffey. During the remainder of the present field season it is proposed to finish St. Clair and Clay counties, if time permits. So far as this work has been examined, particularly the finished maps of Tazewell and Clinton counties, it is believed that the results will be of material benefit and value to the farmers. Thirteen soil types were recognized in Tazewell County and seven in Clinton County and their relation to crops reported upon.

A copy of the soil map and report on the Tazewell area has been sent to one of the most intelligent and progressive landowners, with the request that the work be critically examined and freely criticised, so that we may get advice in advance of publication as to the practical utility and usefulness of the work and suggestions as to other lines that could be profitably developed.

So far as the Bureau is at present informed this work has aroused a great deal of interest, and it is believed that it will be of value to the people. Requests have been made for upward of 25,000 copies of each of these reports, with accompanying maps, to supply the local demand which is likely to arise. So much interest has been taken in this survey that urgent requests have been made by the Illinois experiment station that the work shall be continued in the State, and it is proposed to assign a party to the State for the entire field season of

nine months during the coming year. It is understood that the station will continue its cooperation, and possibly arrangements can be made for more than one party, so that the work may progress rapidly.

One of the most serious problems encountered in the soil survey, particularly in Clinton County, is in the hardpan, or the compact nature of the underlying clay subsoil, in some of the soil types. This not only renders cultivation difficult, but makes crops uncertain under certain climatic conditions, and an investigation of the cause of this and a possible remedy is now engaging the attention of the laboratories of the Bureau.

INDIANA.

No work was carried on in this State during the past fiscal year, but a party is at present engaged in making a soil survey of Posey County. This is in charge of Mr. Marean, and the whole area of the county is to be surveyed. This is particularly in the interest of the truck growers, as large quantities of watermelons and other truck crops are produced on some of the sandy soils of the area.

While there has been some demand for the extension of this work to include the whole area of the State, the plans at present contemplate a survey of only three months' duration in Boone County during the next field season.

IOWA.

During the past fiscal year a soil survey has been made around Dubuque, under the charge of Mr. E. O. Fippin. Eight soil types have been recognized and their relations to crops reported upon.

Rather strong demands have come for the continuation and extension of this work to include the entire State, but it is proposed to spend but six months during the next field season in surveying a part of Cerro Gordo and Story counties in the interest of sugar-beet production, as well as of general farming, stock raising, and dairying.

KANSAS.

During the past field season 461 square miles have been surveyed around Wichita. It was expected that this would be a very uniform area, but nine soil types were encountered, each with distinct properties and adapted more or less to different crops or requiring different methods of cultivation. The possibilities are shown of some degree of specialization of crops and the introduction of fruit interests to take the place of the almost universal crops of wheat and corn, which it is believed will be of value in the further development of the agricultural interests of the area. This work has been in charge of Mr. J. E. Lapham.

It seems desirable to spend about six months in the survey of a portion of the Parsons sheet of the Geological Survey, in the north-

central part of the State, in what may be considered the beginning of the semiarid portion of the West.

KENTUCKY.

During the past fiscal year a survey was made of Union County, which has an area of about 330 square miles, under the charge of Mr. Marean. Eight types of soil were recognized, and while apparently the soils are quite uniform in texture and natural fertility, the possibilities of introducing new industries and better methods of cultivation were clearly indicated. At present the area is given up almost exclusively to wheat culture, but there are good opportunities for greater diversification through improvements in the management of soils, the rotation of crops, and in growing products new to the area.

Demands for soil-survey work in Kentucky have been quite strong, and it seems desirable to assign a party to that State for nine months during the next field season, the surveys to include Henderson, Christian, and Scott counties. This work will be mainly in the interest of the tobacco growers, stock raisers, and general agricultural interests.

LOUISIANA.

A soil survey was made during the last fiscal year by Mr. W. H. Heileman in the Lake Charles area in the interest of the rice growers, an area of 202 square miles having been covered. Six types of soil were recognized in what was supposed to be a uniform area, and it was found that the relation of these soils to the yield of rice was quite marked, and the desirability of extending the survey to other rice districts was clearly recognized. Moreover, under the present system of exclusive rice culture, not even sufficient food for the stock is produced, while meat and vegetables for the support of the people are imported in large part from other States. There is no reason for this so far as the soils or climatic conditions are concerned, and it is pointed out that a proper diversity of interests would materially add to the welfare of the community.

It seems desirable to spend three months during the next field season in Acadia Parish in the interest particularly of the rice, sugar, and tobacco producers.

MARYLAND.

Very strong demands have come for the continuation of the surveys in Maryland to include the whole of the State, and particularly of Worcester, Somerset, and Baltimore counties, and it is proposed to assign a party there for six months during the next field season.

During the past fiscal year Harford County, covering an area of 418 square miles, has been surveyed by a party under the charge of Mr. W. G. Smith. There is no place where the survey has been car-

ried on where more interest has been manifested and more use has been made of the work than in this State. Possibilities have been shown, particularly in Prince George, St. Mary, and Calvert counties, of the specialization of crops in the line of fruit growing, trucking, and general farming and dairying, which would very materially benefit the people and add greatly to the prosperity of the community.

While much work has already been done in this State, it is believed that the intelligent interest and appreciation shown in the results of the work justify the Department in pushing the surveys and giving the people the information they seem to need, and which they appear ready to benefit by in the practical extension of their agricultural interests and in developing the prosperity of the State.

MASSACHUSETTS.

No work has been done in this State since 1899, and the establishment of the profitable Sumatra tobacco culture has aroused a decided demand for the extension of the survey of 1899 in the Connecticut Valley northward to the State line and on either side of the area which has already been surveyed. It is proposed to spend three months during the next field season in the extension of this work, in the interest particularly of the tobacco growers.

MICHIGAN.

During the past fiscal year Allegan County, covering an area of 828 square miles, has been surveyed under the direction of Mr. E. O. Fippin. This work was undertaken particularly in the interest of the fruit growers along the lake shore and of the sugar-beet and general agricultural interests. This appears to be one of the most valuable pieces of work the Bureau has done, and it is believed that the results, which form a part of the report of the field operations for 1901, will be of very great value to the people in the extension of their present industries, the improvement of methods of cultivation, and the development of new crops, which it is believed can successfully be introduced. The experience of the people of this section will also prove of value to other communities, and the lessons taught by the soil survey will, it is believed, have value outside of the area.

No work is contemplated for this State during the next field season, but strong demands have come for an extension of the survey, and it is believed that it should be resumed at the earliest practicable time, particularly in the interest of the sugar-beet and fruit growers.

MINNESOTA.

No work has been done in the State, but strong demands have come for the extension of the soil survey, and it seems desirable to assign a party there for six months during the coming field season, the first area to be surveyed being probably Lyon County.

MISSISSIPPI.

During the past fiscal year the Bureau has mapped an area of 656 square miles around Yazoo City, the work being in charge of Mr. Jay A. Bonsteel.

About one-third of the area is in the uplands and two-thirds in the Yazoo and Mississippi Delta. The upland soil is a typical loess, and it has been suggested, as a result of the survey, that alfalfa can be produced on it as a basis for stock raising. In its present condition it is little esteemed as a cotton soil.

It was supposed that the delta would present a very uniform soil condition, but four soil types were recognized, each with very distinct agricultural values. The Yazoo clay is the most productive cotton soil, yielding from $1\frac{1}{3}$ to $1\frac{2}{3}$ bales per acre, and even more under the best methods of cultivation. This, however, covers only about 17 per cent of the delta. The Yazoo loam, covering about 6 per cent of the delta, yields from three-fourths to 1 bale of cotton per acre. The Yazoo sandy loam, covering 9 per cent of the delta, produces about three-fourths of a bale to the acre, while the Sharkey clay, covering 68 per cent of the delta, is not cultivated on account of the annual overflow. The flood waters leave the land about the 1st of June, but although the land is subsequently dry it is then too late for crops to be put in.

It has been pointed out, as a result of this soil survey, that the Yazoo sandy loam is a typical early truck soil, and that, with the prevailing climatic conditions, potatoes or other truck crops would prove a remarkably profitable industry on this soil.

The Sharkey clay is a wonderfully productive soil, and it appears from the investigations that have been made that the engineering problem of protecting it against the annual floods would not be very difficult, nor expensive when the value of the soil so reclaimed is considered. It is believed that these three suggestions, if followed by the people, will well repay the money expended in the survey.

It is proposed to continue and extend this work to include a larger area of the delta lands and possibly to take up one other area in the State, devoting in all about six months in the next field season to the work.

MISSOURI.

During the latter part of the past fiscal year Mr. Fippin was assigned to survey Howell County, in the fruit area of the Ozark region. It is probable that the whole area of this county will be surveyed during the present field season. It has been found that the soils are remarkably uniform and that the fruit interests can be extensively developed, but it is advisable that the methods be improved to attain the highest commercial success.

The demand for the continuation and extension of this work in Missouri has been so great that it seems desirable to assign a party there for nine months for the survey of Shelby, Saline, and Webster counties during the next field season.

MONTANA.

During the past fiscal year the Billings area, comprising about 105 square miles, has been surveyed under the direction of Mr. C. A. Jensen. Considerable trouble and loss has resulted from the rise of alkali in this area, and the survey was planned with particular reference to determining the possibility of preventing this trouble and reclaiming the land already damaged. It is considered quite feasible to accomplish this object, and it is probable that a demonstration will be made of the efficiency of proper drainage in preventing the rise of alkali and in reclaiming the alkali soils of this locality.

It would seem desirable to assign a party to this State for six months in the next field season to make surveys in the Gallatin Valley and in the Milk River Valley around Glasgow.

NEBRASKA.

No work has heretofore been done in this State, but it is proposed to assign a party for nine months of the next field season to make soil surveys of the Grand Island and Holdrege areas in the interest particularly of the sugar-beet industry.

NEW JERSEY.

During the fiscal year just passed a survey of the Salem area, comprising 493 square miles, was completed under the direction of Mr. Bonsteel, and a survey of the Trenton area, under the charge of Mr. Burke, has been started and will be completed during the present field season.

The Salem area lies wholly within the Coastal Plain region and has eleven different types of soil. These are adapted to various truck crops, fruit interests, and general farming. The people have already recognized the relation of the soils to crops and have adapted their industries to the various soil areas. The success has been so remarkable that the lesson may well be carried to other localities along the Atlantic coast where similar soils prevail.

The Trenton area lies partly in the Coastal Plain and partly in the Piedmont Plateau, and gives even a wider range of soils. This area is particularly adapted to specialization of crops and the building up of widely different agricultural interests.

The interest in this work justifies its continuation, and it seems desirable to spend six months during the next field season in the survey of the Monmouth Shore area, east of and immediately adjoining the Trenton area.

NEW YORK.

During the past fiscal year a soil survey was made of the Westfield area under the direction of Mr. Burke, and of the Elmira or "Big Flats" area under the direction of Mr. Mesmer.

The Chautauqua grape belt, extending for 30 miles along the Lake Erie shore, is within the first-named area. The old beaches, where the grape industry was first developed, have been outlined upon the map, and the Dunkirk clay, upon which the industry has since been developed, is also located, as well as several other foreland and upland soils adapted to general farming and dairying.

The survey of the Elmira area was undertaken particularly in the interest of the tobacco growers, and more especially to see if the cultivation of Sumatra tobacco could be extended there, and to form a basis for other tobacco investigations for the improvement of their present crops. The results indicate that the Sumatra tobacco can not successfully be produced within the area surveyed, except in one small area of not over 10 or 15 acres, where it might be grown. An experiment is in progress to determine this point, although this is not under the control of the Department. The results of the survey point to the need of further investigations of these soils, which under the present methods of cultivation require large annual applications of stable manure to produce satisfactory yields of the crops of the locality. There is an opportunity here for the work of the new division of soil management, which would probably yield results of value to the people.

During the present field season the survey has been extended to the Lyons area in the interest particularly of the sugar-beet growers. It is proposed during the coming field season to detail a party for nine months to make a soil survey of the whole of Long Island. This is particularly in the interest of the truck growers, and it is believed that the results will be of considerable interest and value.

NORTH CAROLINA.

During the past fiscal year a survey has been made of the Alamance County, Cary, and Craven areas under the direction of Mr. Coffey and of the area around Hickory under the charge of Mr. Caine.

Alamance County is in the Piedmont Plateau, and the work was undertaken in the interest of the cotton growers and general farming. Formerly this was an important bright-tobacco section, but the growth of this industry in the eastern part of the State has been the cause of a decline in tobacco production in the area, and the soils formerly adapted to this special industry have depreciated considerably in value. Various suggestions of a practical nature in the line of improved methods of cultivation and the introduction of new crops and new industries have been made as a result of the soil survey.

The work in the Craven area was carried on particularly in the interest of the truck growers and in order to outline the truck soils in this area, which is not as yet very thickly settled.

The work in the Hickory area was in the interest of general farming and, in the mountainous portion, of fruit growing. It is proposed to extend this work during the present field season to the Mount Mitchell area in the interest of the fruit growers.

There is no more interesting development at the present time in the Atlantic coast States than that of the fruit interests in the mountains of Virginia, North Carolina, Georgia, and Alabama. From the work so far done in these States it is clearly apparent that the soil has an important bearing on the different fruit crops, and the apple and peach soils can be identified and outlined as a basis for the intelligent development of these industries. Not only are certain soils adapted to apples, but certain varieties of apples do better on some soils than on others, and the same is probably true of other fruits.

The North Carolina department of agriculture has cooperated very cordially and very helpfully in this work, and it appears desirable to continue this cooperation, assigning a party there for nine months during the coming field season to extend the soil survey.

NORTH DAKOTA.

Very strong demands have come from this State for the extension of the soil survey to include most of the arable portion of the State. It has been impossible until recently to start the work there, but a party has just been assigned to the Grand Forks area, in the Red River Valley, under the direction of Mr. Jensen, who has had wide experience in similar areas in Utah and Montana.

Considerable quantities of alkali are encountered, but generally at a sufficient depth below the surface to enable the annual crops to be produced. The surface foot is usually free from alkali, and as there is no irrigation, and little chance for irrigation, it is believed that there is little danger of the alkali coming to the surface and spreading. It seems a risky thing, however, to have the valuable crops of the locality growing over and so close to these alkali salts, and the possibility of the rise of this alkali should be fully investigated. If it were in an area where water was available for irrigation, it could safely be predicted that the land would quickly be injured by the rise of alkali, but with no opportunity for irrigation the chances are that conditions may not become more serious than at present. This is a question, however, that these investigations will have to solve. The work is being carried on in cooperation with the State geologist.

It seems desirable to assign a party to this State for six months' work during the next field season.

OHIO.

During the past fiscal year work has been started in the Columbus area and in the Toledo area, and it is believed these will both be completed by the end of the present field season. The surveys are being made under the direction of Mr. W. G. Smith.

The Columbus area is devoted to general farming. While there is a certain uniformity in the soils, one of the principal soils is preeminently a wheat land and another chiefly a corn land, the character of the soils showing very strongly their peculiar agricultural values in the crops produced and in the success of these crops.

It is proposed to assign a party to this State during the next field season to survey a part of Ashtabula County in the interest of the fruit and tobacco growers.

OREGON.

No surveys have been made in this State, but it is proposed to assign a party there for six months during the next field season to survey an area around Salem, in the Willamette Valley.

PENNSYLVANIA.

During the past fiscal year a survey of the Lebanon area, in the interest of tobacco growers and general farming, was completed under the direction of Mr. Smith. The interest taken in the survey around Lancaster leads me to believe that the results of this work will be found of interest and practical value in the still higher development of the agricultural conditions of the locality.

It seems desirable to assign a party for three months during the next field season to make a soil survey of Clinton County, particularly in the interest of the tobacco growers.

PORTO RICO.

During the past fiscal year an area of 330 square miles was surveyed in a strip about 10 miles wide, extending from Arecibo to Ponce, the work being in charge of Messrs. Dorsey and Mesmer. Twenty-two types of soils were recognized, all of them markedly different from the soils encountered in the United States. Much of the country is rugged, broken, and mountainous, and as there were no available maps, the base map had to be made as the soil survey progressed. Many of these soils are not well adapted to agriculture, but the report deals fully with the conditions as they were actually seen, and it is believed that it will form a basis for a more intelligent development of the agriculture of the island.

It is deemed advisable that this survey should be extended to include the whole area of the island, of which about one-tenth is included in the area already surveyed, but under a change made in the wording of

the appropriation bill it will be impossible for the Bureau of Soils to continue this work. It will be recommended that such changes be made in the next appropriation act as will enable the Department to resume operations in Porto Rico. I know of no more valuable work the Department can do than to thus investigate the actual conditions in these island possessions, and the extension of the soil survey to them should give a basis for the best and most economical development of their agricultural resources at a time when so many people are looking to these islands for investments and when the people of the islands themselves need all the help that can be given them.

SOUTH CAROLINA.

During the past fiscal year an area of 686 square miles has been surveyed around Abbeville, and on the completion of this work the party, in charge of Mr. Taylor, will make a survey of Darlington County, particularly in the interest of the bright-tobacco growers and truck growers.

It is proposed to detail a party for nine months during the coming field season to survey an area in Spartanburg, Pickens, and Orangeburg counties, particularly in the interest of the cotton, fruit, and bright-tobacco growers.

SOUTH DAKOTA.

No surveys have been carried on in this State, nor are any contemplated for the present field season. It seems desirable, however, to assign a party for a period of three months during the next field season to start a survey in Brookings County.

TENNESSEE.

During the past fiscal year a survey in the interest of the tobacco growers was made of Montgomery County, embracing an area of 547 square miles, under the direction of Mr. J. E. Lapham. Among the important results of this survey has been the suggestion that one type of soil which is at present of little agricultural value and which covers a considerable area, is adapted to fruit growing, and it is believed that this interest could be introduced with profit to the community. It was hoped that the survey would be the basis of an investigation of the possibilities of improving the tobacco interests, but the appropriation for the Bureau was not sufficient to enable this to be done.

It is proposed to extend the soil survey to Greene, Cumberland, and Davidson counties, assigning a party to this work for a period of about nine months during the coming field season.

TEXAS.

During the past field season the Willis area of 215 square miles has been surveyed in the interest of the tobacco growers, and a party of

tobacco experts has been placed there to investigate the possibility of producing a more desirable filler tobacco.

The Alvin area was also started under the direction of Mr. Bennett, and this and the Brazoria area will probably be completed during the present field season. This is particularly in the interest of the fruit growers around Alvin and of the sugar interests around Brazoria.

It is also proposed to survey an area during the present field season around Vernon, in the Panhandle of Texas, in the interest particularly of the wheat growers and with the view that the results may be useful in the introduction of macaroni wheat.

Representations have been made to the Department which make it appear advisable to assign a party to this State for at least nine months during the next field season for surveys, particularly in Tyler County, and also around Austin and San Antonio.

UTAH.

The soil-survey work of 1899 and 1900 has been discontinued in this State, but it is proposed to assign a party for six months during the next field season to survey the irrigable lands around Utah Lake.

The work around Salt Lake City is being followed up by a drainage investigation having for its object the reclamation of some of the alkali lands.

VERMONT.

A strong demand is made for the extension of the soil survey in the Connecticut Valley in the interest of the tobacco growers, to see if the cultivation of the Sumatra tobacco can not be extended to that latitude. It is proposed to assign a party for three months during the next field season to extend the soil survey of the Connecticut Valley.

VIRGINIA.

During the last fiscal year the Bedford area and the Prince Edward area have both been completed, and the Harrisonburg area has been begun. All of this work has been under the direction of Mr. C. N. Mooney. It is proposed to finish the Harrisonburg area and the northern part of the Buckingham sheet of the Geological Survey during the present field season, and to assign a party to this State for nine months during the next field season to survey the southern half of the Buckingham sheet and the whole of the Harpers Ferry sheet, as well as an area around Norfolk.

The most important work has been done on the Bedford and Harrisonburg areas. These include portions of the Piedmont Plateau, of the Valley of Virginia, and of the intervening mountain area. The results of the work on the plateau and in the valley are important, but the greatest interest centers in the survey of the mountain soils, in

which the fruit interests are developing. It has been found that the different varieties and types of fruit are best adapted to different soils, and as the survey extends and these soils are being outlined the basis is presented for the most intelligent development of the fruit interests.

The Harpers Ferry area will take in a considerable portion of the valley, as well as of the plateau, and the results of the work should show the reason for the decline in agricultural value of the valley soils, and should suggest means for reviving the agricultural interests of what was once a prosperous community on what was considered the highest type of agricultural land.

The survey around Norfolk will be in the interest of the truck growers.

WASHINGTON.

During the past fiscal year the Walla Walla area, covering about 150 square miles and including practically all of the irrigable lands of that locality, was surveyed under the direction of Mr. Holmes. The work has just been finished and the results can not yet be reported.

WISCONSIN.

No work was done in the past fiscal year in this State, but Mr. Jay A. Bonsteel was assigned on July 1 of the present fiscal year to the Janesville area to survey the soils around Janesville, Stoughton, and Edgerton. This survey is in the interest of the tobacco growers, and is particularly to see if the Sumatra tobacco is likely to be adapted to this section, and to be a basis for the improvement of the type of tobacco at present grown.

It seems desirable to assign a party to this State for six months during the next field season to make a survey, particularly of Eau Claire County.

WYOMING.

No soil surveys have as yet been made in this State, but it is proposed to assign a party for six months during the next field season to survey the soils of the irrigable part of the Laramie sheet of the Geological Survey.

ESTIMATED COST OF PROPOSED SOIL SURVEY WORK.

During the fiscal year 1902 about $40,000 was spent on the soil survey with 10 survey parties. For the fiscal year 1903 an allotment of $60,000 has been made for this work with 15 soil survey parties. For the fiscal year 1904, for which estimates are being submitted to Congress, on the basis of the plans which have just been given for the continuation and extension of the work in order to meet the most urgent demands, an allotment of $120,000 would be necessary. This is based upon a total estimate of 243 months of field work contem-

plated by the above plans, which will require for its completion within the fiscal year 30 field parties, costing approximately $4,000 each, calculated on the basis of the work done during the last three years. Each party would survey about 1,200 square miles, making a total estimated area of 34,800 square miles, or 22,272,000 acres, in 38 States and Territories, which would be surveyed in that year.

Publication of the Report and Maps.

The results of the field work of the Bureau of Soils are published under authority of the joint resolution of Congress providing for the printing annually of the Report of Field Operations of the Division of Soils, Department of Agriculture, approved February 23, 1901. Under the interpretation of this resolution by the Public Printer, the report and accompanying papers have to be published at one time in a single volume, with the maps in a separate case. This is undesirable in many ways, for work that is finished in the winter or spring has to be held in the office until the succeeding February, when the report of the field work is all completed and sent to the Public Printer. This delays the publication for nearly eighteen months after the work is completed, and the public interests require that the work should be published as soon as possible after the completion of the field work. Furthermore, the publication of all the reports and maps in a single volume makes a bulky and expensive book to send to any person requesting information about a particular area. The demand also is so great that, although the Department has 8,000 copies of the bound report to distribute and the Senate and House of Representatives have together 9,000 copies, the Department received upward of 2,000 requests for the 1900 report which could not be filled. Reprints were ordered of all the reports, in editions ranging from 500 to 1,500 copies, and these were quickly exhausted. As the work becomes better known, many requests are coming from Senators and Representatives, and the opinion is freely expressed that the full value of the work can not be secured unless there is a liberal provision for its distribution within the area in which the work has been done. The requests for reprints of the 1901 report indicate that from 3,000 to 10,000 copies will be required to satisfy the demand, notwithstanding the fact that some of the States are ordering reprints of the maps for their own distribution.

In view of these facts it is recommended that the joint resolution be so amended as to permit of the Report of the Field Operations of the Bureau of Soils being published in parts or volumes as the work is completed, and also to provide for the reprinting as separates of the reports of field parties, with their accompanying illustrations and soil maps, in editions sufficient to allow 500 for each Senator to whose State the survey relates, 2,000 for each Representative in whose district

the survey may be made, and 1,000 for the use of the Department of Agriculture. This will insure the prompt publication of the results of the survey and a distribution through members of Congress, which my present information seems to indicate is desirable if the full value of the soil survey work is to be attained in the dissemination of the information thus gathered, promptly and freely, to the people who are interested.

Needed Legislation for Insular Surveys.

It seems desirable that the benefits derived from the soil survey work should be extended to the insular possessions of the United States, and I recommend that the act making appropriation for the Bureau of Soils be so worded as to permit of the sending of soil survey parties to Porto Rico and Hawaii. Numerous demands have come for the extension of the work in both Porto Rico and Hawaii, and it seems probable that the work will be of particular value to these islands in the present state of the building up of their agricultural resources.

The work has already been started in Porto Rico and in the Philippine Islands, the latter through cooperation with the War Department and the civil government of the islands, in the detail of Mr. Clarence W. Dorsey to the Philippine government and the defraying of his salary and the expenses of the soil survey work by that government. The work can not be continued in Porto Rico nor started by the Department in any other of our possessions without a change in the wording of the appropriation act.

Investigations in Soil Management.

In the development of the soil survey many questions are presented of the possibility of improved methods of cultivation and handling of the crops, as well as of introducing new methods, new crops, and new industries. Some of these suggestions need more time and more study than can be given by the soil-survey parties in the limited time in which they remain in an area. Furthermore, the presentation of such suggestions in printed reports is apt to fail of securing proper recognition from the conservative farmer, who follows pretty much the methods used by himself and his predecessors on the land. Without these further studies and a practical demonstration of their efficiency many of the important results of the soil survey are liable to be lost.

For these reasons a division of soil management has been instituted in the Bureau, in charge of Prof. Franklin H. King. During the past year exceedingly delicate methods have been devised for the analyses of soils in the field. They are so sensitive that the amounts of nitrates, phosphates, sulphates, and the like which may be present, as indicated by water solutions, can be determined to within 4 or 5

pounds per acre 1 foot deep. With these methods it is possible to detect throughout the year fertilizers which were applied in the spring, and to trace the movement of these fertilizers from the place where they were applied down through the different depths of the soil. It has been found possible to show noticeable differences in the chemical composition of the soil in the same field, in some parts of which the crops are growing well, and in other parts of which they are but poorly developed. It appears that the time has arrived, looked forward to with much interest by scientists and practical men alike, when an analysis will show the need of any particular soil for certain fertilizers. It is too early to make a positive statement of this kind, but the indications are that this can soon be accomplished.

A considerable amount of work has been done with these methods on the soils of eastern North Carolina and of Wisconsin, and quite recently many of the important soil types which have been established by the Bureau in Georgia, North Carolina, South Carolina, Virginia, Maryland, New Jersey, Pennsylvania, and Wisconsin have been analyzed by these methods. These types represent all grades of soil, from the most productive to those which are quite unproductive; soils that are adapted to truck crops, tobacco, fruit, wheat, and corn; and soils under a range of climatic conditions with rainfall varying from 25 to 45 inches per annum.

The results of this work have led us to look upon the soil moisture as a great nutritive solution existing over the surface of the earth, the composition of which is everywhere approximately the same. The soil is a heterogeneous mixture of minerals, the predominant ones being silica, feldspar, mica, and other like silicates, resulting primarily from the disintegration and decomposition of igneous rocks, spread out often through the action of water over vast areas of land. All these minerals are but slightly soluble, and it is not unreasonable to expect that such a heterogeneous mixture of silicates in contact with water should yield a soil solution having sensibly the same composition and concentration. The older experimenters in Germany found that in making up solutions for water culture or for sand culture the concentration and composition of the nutritive solution must be the same within relatively narrow limits for success in plant development. The results of the past season indicate that the differences in the composition and concentration of the dissolved material in the soil moisture of various types of soil of widely different localities and of different agricultural values are little if any greater than the differences to be found in one and the same type of soil under good and under poor farm management.

The "early truck" soil of the Atlantic coast may be deficient in plant food and may require fertilizers for the best development of the crop, but even with such an application as would make these soils as

rich in plant food as the prairie soils of the Middle West, these light truck soils could not economically be made to produce as large corn crops as the prairie soils. The difference in the agricultural value of these different types appears to depend not so much upon the chemical composition as upon the physical properties of the soils, and especially upon their relation to moisture. In other words, the chemical characteristics of the soil influence the yield of crops, while the physical characteristics have generally the greater importance in determining the kind of crop adapted to the soil.

This work will require much further investigation before these statements can be definitely proved, but the amount and character of the evidence so far obtained is such that these ideas may be taken safely as working hypotheses. They are now serving us in this capacity in suggesting and giving direction to studies which are confidently believed to have far-reaching importance for agricultural methods and practice, studies which in all probability could not have been conceived or planned without the investigations which have just been briefly outlined. The results of the work indicate, as might be expected, that the composition of the soil moisture is largely influenced both by the cultivation and by the cropping of the soil, and appear to show in what way and to what extent cultivation can be depended upon to change these important characteristics.

The results of the last year's work also seem to indicate the very superficial nature of the droughts which so seriously affect crops in the Eastern and Middle Western States. It has been frequently observed that in a time of drought, when the surface soil becomes desiccated and the plants are suffering, the subsoil at a depth of 1 or 2 feet contains but little less than the average amount of moisture, and it has frequently been observed that the crops are much more shallow rooted than they are in the far West. This has been variously ascribed to the uniform texture of the soils and subsoils in arid regions, and to other reasons, but the true explanation seems to be that with our frequent and excessive rains in the spring and early part of the growing season, the crops find sufficient moisture near the surface and develop a superficial root system. When the drought comes and the surface soil loses its moisture, the crop suffers because it is not provided with a deeper root system. In the far West, where spring and summer rains are rare, the crop is planted upon a soil which is always uniformly moist to a considerable depth, and with no subsequent rains the plant develops a deeper root system, which enables it to survive long periods of drought that would seriously affect it if it was subjected to frequent showers during the early period of its growth. It is a familiar fact that a lawn which once is watered during a dry season will have to be frequently watered or the grass will suffer oftentimes more than if it had not been watered at all. The first watering induces a superficial

root development, which must be supplied frequently with water. What can be done to prevent this tendency and to overcome the effect of droughts is a subject of the utmost importance, and one which will receive the attention it deserves.

I know of no line of work which has been undertaken of more fundamental importance than the work of the division of soil management, nor one which offers a promise of more valuable results to the agricultural interests. When these fundamental problems have been established they will give a reliable basis for the development of better methods of cultivation, fertilization, and of cropping.

Tobacco Investigations.

Since my last report the commercial success of the shade-grown Sumatra tobacco in the Connecticut Valley has been assured. Last year 41 acres of shade were erected by 13 farmers, cooperating with the Department of Agriculture, 35.88 acres of which were planted to Sumatra and the rest to the ordinary Connecticut Habana seed tobacco. The expenses of this work, amounting on an average to about $657 per acre, were borne by the farmers, the Department of Agriculture exercising supervision over the work and directing all the operations. The Department also reserved the right to offer the tobacco for sale, for the purpose of obtaining official information as to the commercial value of the product, which it would have been impossible to obtain if the tobacco had been disposed of at private sale. Accordingly, after it had been carefully cured and assorted under the direction of the Department's experts, the tobacco was catalogued and offered for sale at public auction at Hartford, Conn., on May 1, in accordance with the wishes of the various growers. A committee of tobacco brokers, with Hon. E. Stevens Henry, Congressman from the First district of Connecticut, as chairman, was invited to cooperate with the Department in the management of this sale. The committee consisted of Messrs. M. E. Flaherty, New York; Steven G. Ruth, New York; S. M. Seymour, New York; Capt. Darius Ferry, New York; James Ertheiler, New York, and Herman G. Vetterlein, Philadelphia.

The committee took a great deal of interest in the work and rendered very efficient services in the matter. Credit is due them for the time and expense which they personally contributed in the interest of this investigation and of the Connecticut growers.

The tobacco was offered for sale at public auction from sworn samples. As each grower wanted to sell his crop independently of the others, many of the bales had mixed sizes and even mixed grades. Furthermore, the leaf had not been tried by the manufacturers, and there was some hesitancy in bidding on this account. This accounts for the considerable variation in the price. It is estimated by the Department's experts, as stated in Bulletin No. 20 of the Bureau of Soils, that the tobacco cost on an average, baled and ready for market,

about 51½ cents a pound. The ordinary tobacco grown in the open fields in Connecticut brings on an average from 18 to 20 cents a pound. The average price paid for the shade-grown tobacco was $1.20 a pound, the price varying from $2.80 per pound for the best to 25 cents a pound for some of the mixed bales. The crop that brought the best price sold for $1.63 per pound on the average.

On the whole, it is believed that the auction sale was very satisfactory, but it is thought that the prices for this year's crop will be even higher, as indicated by the great demands for the product and by the favorable reports that are coming in from the cigar manufacturers who have used this leaf. The aggregate of the prices obtained at the auction shows a very handsome financial transaction.

The total area cultivated in Sumatra tobacco in 1901 was 35.88 acres. There were produced 51,308 pounds of cured tobacco, and actually baled 41,046 pounds, the difference being the loss on account of fermentation, trash, and filler leaves. The total cost of production, estimated at $657.17 per acre, was $23,579.26. The total value, estimated at $1.20 per pound, the average price obtained at the sale, was $49,255.20. This gave a net profit to the growers of $25,675.94, or 108.8 per cent. This does not include the cost of the land, barns, or warehouses, nor the interest on the investment so represented, but does include the whole cost of the shade, the framework of which is expected to last for from five to eight years. The profits per acre were as follows: Of baled tobacco, exclusive of trash, there was obtained 1,144 pounds per acre; the cost of this was approximately $657.17 per acre; the value, at $1.20 per pound, was $1,372.80, giving a net profit of $715.63. The best crop, which was raised on a lot of about 6 acres, gave a yield of 1,026 pounds per acre; the estimated cost was $649.86 per acre; the total value at $1.63 per pound, the average price obtained for this lot, was $1,672.38, giving a net profit of $1,022.52 per acre.

A great deal of interest has been felt, of course, as to the experience of the cigar manufacturers in handling this product, and the reports have been anxiously awaited. Very favorable notices have been published from time to time in the press and various trade journals, but in order to obtain direct and reliable information the Department addressed three of the largest cigar manufacturers in Hartford and vicinity, who it was known had purchased some of the stock at auction. In reply to these inquiries the following letters were received:

HARTFORD, CONN., *August 25, 1902.*

DEAR SIR: I beg to inclose you my foreman's report on shade-grown tobacco. (Mitchelson, 1901 crop.) The appearance of the crop in the sheds this year shows an improvement in color; there are more brown leaves, with less of the green cast so much in evidence last season. I hope the growers will make a special effort to raise shade-grown wrappers only on land that produces a sure burn. This type is only for wrappers, and a perfect burn is quite important.

Respectfully, yours, CHARLES SOBY.

Report to Charles Soby by E. M. Roszelle, foreman of factory, on test of shade-grown wrappers, Mitchelson crop, 1901.

Shade-grown wrappers, as tested under my supervision, will show some remarkable results as to yield of product and of the effect on quality of cigars by their use. By comparison with a like quantity of imported Sumatra wrappers as to yield in product, the difference in favor of the shade-grown wrappers is apparent to all.

Our test on one bale of shade-grown wrappers of 155 pounds net weight shows the enormous yield of 85,432 cigars, an average of $29\frac{1}{35}$ ounces per thousand. The same stock, as prepared by the tobacco strippers for the workmen's tables, shows an average of $27\frac{3}{4}$ ounces per thousand, which includes waste of all descriptions in the stripping room. Our tests on imported Sumatra wrappers of same weights show an average of 70,000 cigars to the bale, with greater loss in stem and wrappers in preparation.

In casing for the stripping room, the shade-grown wrappers take the water very nicely and show no bad effects, the wrappers being much easier handled by the caser than Sumatra. It does not become matted, but separates without any trouble.

The workmen find no difficulty in working the leaf, as no loss of time or product is caused by the use of shade-grown wrappers. The leaf is very elastic, and works well by comparison with other wrappers tested by us.

The quality of the shade wrappers is excellent, and blends very well with our binders and fillers. I am positive the cigars are improved in quality by its use. I find no trouble with the burn of the leaf in my daily inspection of the wrappers. I have failed to find a single leaf that does not burn perfectly.

As to color, they are not perfect in all respects. I find that about 91 per cent of the stock tested by us was good in color.

All things considered, the points in favor of the shade-grown wrappers may be summed up as follows:

First. Greater yield in product.

Second. Leaves are lighter in weight and color.

Third. Less waste and cost in preparation for workmen's tables.

Fourth. Less loss in weight of stems as compared with Sumatra wrappers.

Respectfully, yours,

E. M. Roszelle.

Suffield, Conn., *September 4, 1902.*

Dear Sir: It is but right I should advise you as to the working quality of the Connecticut shade-grown Sumatra tobacco, from which I purchased at the sale in Hartford, Conn., on May 1, 1902, 20 bales.

I have worked in my cigar factory since then quite a proportion of this tobacco, and I am more than pleased with the results. It is finer and better in every way (in color, texture, and flavor) than the imported Sumatra, and the wrapping qualities are enormous; 20 ounces will easily wrap 1,000 5-inch cigars. I am confident that when cigar manufacturers come to work this tobacco the demand will be far greater than the supply.

Very respectfully, yours, L. P. Bissell.

Hartford, Conn., *September 1, 1902.*

Dear Sir: We have been using the shade-grown tobacco, which we bought at the auction held in this city last May, to some extent all summer. We are using it on a small "perfecto" cigar. It wraps with about 2 pounds to 1,000 cigars. The colors have improved a great deal since last spring. It burns well and tastes well. So far we have not had any complaints from any of our customers about the cigars with this wrapper. We should like it better if it had a little more body, because then it would stand the cold weather better.

Very truly, yours, Leichke & Pletcher.

In another communication Messrs. Leichke & Pletcher report that they could wrap 1,000 of their 5-inch cigars with 1 pound 10 ounces of the leaf, while Mr. Bissell, of Suffield, reported that he was using 2 pounds of the shade-grown leaf to wrap 1,000 of his cigars, and that with a bale of wrappers weighing 140 pounds 102,000 cigars were wrapped. It can safely be said, therefore, that the leaf has successfully stood the test of the cigar manufacturer.

Even before the tobacco was ready for the market or the results of the sale announced preparations were made by the growers to largely increase the acreage. Although the commercial success of the investigations had been fully demonstrated, the industry was so important and involved such an expenditure of labor and capital that, at the earnest solicitation of the growers, the Department's experts were left in the Connecticut Valley for another year to advise with such of the growers as needed their assistance. At the present time the Department is advising and instructing in this way 38 growers in Connecticut and Massachusetts, cultivating 645 acres of shade tobacco. The efforts of the Department in this direction seem to be very highly appreciated.

The season has been distinctly unfavorable. There has been an unprecedented amount of rain, falling in very severe showers, and the season as a whole has been characterized by cool spells and especially cool nights. This has apparently not affected the crop materially, as it is the general belief that the crop at this time is better than that of last year. The season has also been one of unusually severe wind and hail storms. Considerable damage has been done to the outside crops in certain sections of the State, but no damage has been done to the shaded tobacco, as the cloth has protected the leaf from all injury from hail. The damage from wind has also been exceedingly light. The winds have been so strong in places that the posts have been lifted from the ground, but the damage to the tents has been exceedingly slight and there has been practically no injury to the crop.

As to the financial prospects for this year, the following estimate is based on the experience of last year: There are about 700 acres of tobacco under shade, which will produce about 1,000,000 pounds of cured tobacco, or 800,800 pounds of baled tobacco, exclusive of trash. The total cost, at $657.17 per acre—the average for last year—will amount to $460,019. The total value of the baled tobacco at $1.20 per pound, the average price obtained at the auction, will be $960,960. The net profit will be $500,941. It is believed, however, that the cost per acre will be considerably less than last year, and that the price per pound will be greater. The Department believes that this industry has been successfully placed upon a commercial basis, and that there will be a considerable increase in the crop grown next year. We have demonstrated our ability to produce a leaf which is desired

by our people, and for which about $6,000,000 have annually been expended in foreign countries. The demand for this product has always been greater than the supply, and prices have been maintained in a remarkable manner. It may seem strange to some that manufacturers can afford to pay such prices for wrapper leaf, but even at $3 a pound for leaf that will wrap at the rate of 2 pounds to 1,000 cigars, the cost of the wrapper is about six-tenths of a cent. Even at such prices the leaf can profitably be used on a 5-cent cigar. There is so little waste to the leaf, it yields so well in the manufacture of cigars, the color is so uniform, and the grading is so perfect that manufacturers find it actually cheaper to pay $3 a pound for such leaf than to buy domestic wrappers at an average of 20 cents a pound or selected domestic wrappers at from 50 to 60 cents.

SUMATRA TOBACCO IN LOCALITIES OTHER THAN CONNECTICUT.

Considerable interest has been shown, of course, in the possibility of extending the Sumatra tobacco industry to other localities and to other States. It was predicted, as a result of the soil survey of the Lancaster area, Pennsylvania, that the Sumatra tobacco could be successfully grown under shade on the narrow strip of Donegal gravelly loam bordering the Susquehanna River. Experiments carried on this year by the Pennsylvania experiment station, in cooperation with this Department, in growing Sumatra tobacco under shade on a small tract of about 1 acre appear to have demonstrated the correctness of this prediction. The crop has been harvested and, judging from the product in the curing shed, it is of good quality. It is not believed by the Department experts that equally successful results will be attained on other soils in this area.

In response to demands from one of the principal New York tobacco districts, a soil survey was made this season of the Big Flats area in the Chemung Valley, New York. As a result of this survey, it is not believed by the Department experts that any considerable success will attend the growing of Sumatra tobacco on the soils of that locality, with the exception of a very small area of not exceeding 10 acres, where an experiment has been actually carried on by a gentleman familiar with the soils of the Connecticut Valley, who selected this tract because it represents the type of land that is found in Connecticut.

A soil survey has also been made of a considerable area in the Janesville area, Wisconsin. Two experiments of growing Sumatra tobacco under shade have been tried there, and the results at the time of harvesting indicate a fair degree of success. The Department does not believe, however, that the product of the soils of the Janesville area will approach in quality or in value the product raised in the Connecticut Valley. It is not intended by this to imply that the leaf can not be successfully grown in the Wisconsin area, but from

the information at present obtainable it does not seem that the product will be of equal value with that of the Connecticut Valley. The Department is still of the opinion that the conditions essential for the raising of a high grade of Sumatra tobacco are limited in extent and can be closely defined by the soil survey.

INVESTIGATIONS IN THE FILLER TOBACCO DISTRICTS.

The experiment of raising Cuban filler in Lancaster County, Pa., last year was not a success. It is believed, however, that this was due to a misunderstanding with the growers and a consequent lack of care and thoroughness in the cultivation and handling of the crop. While it was thought that these investigations should not have been interrupted or discouragement felt at the lack of success in this first attempt, it was impossible for financial reasons to maintain a party in Pennsylvania, as a promise had already been given to start the work in Ohio. Accordingly, more careful plans were made, and a crop was grown on the upland soils of the Miami Valley, under the direct and immediate supervision of the Department's experts. This crop has just been harvested, and it is too early to determine the value of the product. From other crops that have been raised in the locality from imported Cuban seed, which have been fermented by our experts and thoroughly examined, it would appear that a desirable type of leaf, approaching very closely the imported Cuban leaf, can be produced. The quality of the leaf is not at present all that could be desired. There is something harsh about the aroma, but it is thought that this can be considerably toned down, if not entirely eliminated, by thorough methods of cultivation and fermentation.

The tobacco situation in Texas has been thoroughly studied, and it is thought that a desirable leaf will be produced there by careful methods of cultivation, fermentation, and assorting.

CONFERENCE OF TOBACCO EXPERTS.

A conference has recently been held in Washington by the tobacco experts of the Department to consider the general situation and to advise as to the methods to be pursued during next season, especially in Ohio and Texas. Arrangements have been made for experimentation during the coming crop season with good prospects of producing fine filler tobacco in these two States. Leaf has been grown that can not be distinguished from the imported Cuban when properly fermented.

SALARIES OF TOBACCO EXPERTS.

The demand for experts to carry on tobacco investigations has been so great that Mr. Floyd, although receiving as high a salary as, in justice to other officers of departments, it seemed possible to pay him,

and who at the time was getting a larger salary than the Chief of the Bureau who was directing the work, was induced to leave by the offer of compensation about three times as great as he was receiving in the Department. Quite recently his successor has been approached in the same way by a corporation intending to operate in the Connecticut Valley, and it is likely that he will leave the Department to accept a much more remunerative position outside. Two years ago I had to note the loss to the Department of a gentleman who had made some important discoveries in tobacco fermentation, and who was called to Japan at a salary about four times as great as he was receiving in the Department.

It is gratifying to feel that the Department's experts are looked upon with such favor in the commercial world, but these experts are so difficult to obtain, and to train them requires so long a time, that the Department is very greatly embarrassed when they are thus removed because of lack of opportunity to pay them what their services are worth in commercial lines. As this work has been developed by the Department, it seems strange to think that the very success of the work is hindering, if it does not prevent, the successful extension of the investigations.

EXTENSION OF THE TOBACCO INVESTIGATIONS.

The tobacco investigations of the past two years have been carried on with three field parties, at a cost of about $5,000 each, or an aggregate of $15,000 per annum. On account of the great success of this work, and the extraordinary interest taken in its extension to other areas, I recommended last year that the appropriations for the Bureau of Soils be increased so that the allotments for this work could be made sufficient for seven parties of tobacco experts. The appropriations as passed, however, did not allow of this increase, and the allotment this year has been the same as for last. The demands for the services of these tobacco experts have been very great, and I would recommend that three additional parties be organized for work in Pennsylvania, Wisconsin, and North Carolina. This will mean an increase of $15,000 in the allotment, making in all the sum of $30,000 for the tobacco investigations. I feel that the economic results of the work so far done, and the lines of work that are at present being developed, fully justify this recommendation. The reports from the Connecticut Valley alone indicate that nearly $1,000,000 worth of Sumatra tobacco will be grown in the State this year. This has largely increased the price of land; has furnished a market for thousands of chestnut posts from adjacent ridges which have lain idle and unproductive for years; has given employment in a healthful occupation and at remunerative wages to large numbers of men and women; has brought about the production of millions of square yards of cloth by the cloth manufac-

turers, and has opened up the possibility of an enormously profitable industry for the future. It would seem that this experiment alone would fully justify the increase in the allotment that is asked, but when it is stated that we expend annually $8,000,000 for filler tobacco which the experts of the Department believe can be produced in this country, it but adds to the justification of the request for the larger allotment for this work.

Drainage Investigations.

During the year an investigation was started as to the possibility and practicability of reclaiming the soils in the arid regions which have been injured by seepage water and the accumulation of alkali. In cooperation with the Utah experiment station and Mr. C. D. Swann, of Salt Lake City, who has donated land for the purpose and has paid a considerable portion of the field expenses, a tract of 40 acres of alkali land near Salt Lake City has been thoroughly underdrained with tile. This work has been under the immediate supervision of the Department experts, and the work of reclamation is to be under the joint charge of the Department and the Utah experiment station. It is too early yet to speak of the results of this work. It is being watched with the greatest interest by the people of that locality, and it is believed that if the investigation is a success ample capital will be forthcoming to carry on extensive operations in the reclamation of alkali tracts and the prevention of damage to irrigated lands from seepage waters. This work is under the immediate charge of Mr. W. H. Heileman.

Arrangements are being made for the carrying on of similar work at Fresno, Cal., and it is proposed to extend this work to a typical area in Montana and possibly in Arizona, to demonstrate to the people that these unfavorable conditions can be economically controlled. It is estimated that land values in the immediate vicinity of Salt Lake City will be increased at least $3,000,000, exclusive of the cost of reclamation, if they can be reclaimed from the alkali with which they are now impregnated, and it is believed that equally great benefits will result in other portions of the arid West.

In furtherance of this work, Mr. Thomas H. Means, of the Bureau of Soils, has accompanied Mr. Thomas H. Kearney, of the Bureau of Plant Industry, on a trip to Algeria and Egypt to study the treatment of alkali lands, the use of alkaline waters in irrigation, the methods used in the reclamation from seepage water and alkali, and the crops adapted to alkali soils. This investigation has not yet been completed, but sufficient has been heard from the party to indicate that conditions even more serious than those existing in the arid regions of this country are under perfect control, and it is believed that the information thus gathered will be of great benefit to the people of Western America.

BUREAU OF CHEMISTRY.

Examination of Imported Food Products.

The Bureau of Chemistry has continued the examination of imported food products for the purpose of determining if they contain any added substances injurious to health. The Bureau has also collaborated with the Treasury Department in controlling the polarizations of imported sugars and in determining the character of certain other imported products in order to classify them for dutiable purposes. Investigations of the adulteration of food products is one of the important studies of this Bureau, and the work has been especially devoted during the past year to the adulterations of olive oils, with the object of securing an honest market for the olive oils of domestic manufacture which are compelled to compete with cheaper and adulterated oils.

Investigations of Forest Products.

Important investigations, in cooperation with the Bureau of Forestry, have been conducted by this Bureau in connection with economic forest products such as tannin, gums, rubbers, and wood pulps.

Laboratory Tests of Road Materials.

The road material laboratory of this Bureau, which was established in December, 1900, in cooperation with the Office of Public Road Inquiries, tests road materials of all descriptions, free of charge, for practical road builders throughout the country.

Those interested in the construction of a road have only to send samples of their available materials to this laboratory and have the road-making qualities of these materials determined. In the case of materials for macadam roads, the resistance of wear to rock, its cementing value, hardness, toughness, and absorptiveness are determined. After such tests are made it is possible to predict which material will give the best practical results under a given traffic.

Only practical road builders of much experience realize the large amount of money which can be wasted through an improper selection of material. There are generally several materials available in every locality, and the difficulty of selecting the most suitable for a particular road is evident. The only way a proper selection can be made within a reasonable time is by means of physical and chemical laboratory tests.

The laboratory is now equipped for the testing of road materials of every description, as well as cement and concrete for drains and highway bridges.

The large number of samples received from all parts of the country, including our island possessions, attest the value which practical road builders place upon these laboratory tests.

Investigations in the Sugar Laboratory.

Important investigations looking to improving the quantity and quality of table sirups have been made in the sugar laboratory, and critical studies have been undertaken of the influences tending to produce the maximum content of sugar in beets, melons, and other sugar-producing plants.

Studies of Insecticides.

Studies of the various insecticides in common use in agriculture have been conducted with the object of determining the value of their constituents. Since arsenious acid is one of the most common constituents of insecticides, an investigation has been commenced to determine the effect of this body upon the foliage of plants and to ascertain whether any of the arsenic thus applied for insecticidal purposes is found in the food products derived from the plants which have been thus treated.

Study of Environment of Chemical Composition of Cereals.

Extensive collaborative work has been instituted with many of the agricultural experiment stations for the study of the effect of environment on chemical composition of wheat and other cereals and to ascertain the most reliable methods for judging the quality of the soils from their chemical constitution.

Study of Waters used in Irrigation.

The study of the character of waters used in irrigation, especially in the growing of rice, has been begun, to determine the quantity of injurious salts which these waters may contain and the quantities of this water which may be safely used upon the fields.

Establishment of New Laboratories.

New laboratories have been established to study the effects of preservatives and other added substances upon the health of the consumer, with the view of determining the character and amount of such substances which may be safely used in such foods without injury to public health.

A contract laboratory has also been established for the purpose of ascertaining the quality and quantity of materials purchased for the Department of Agriculture and other Departments of the Government, and to establish specifications for such supplies, based on physical and chemical properties.

A drug laboratory has been established also to study the character, standard, and adulteration of drug products. The larger portion of the drugs in commerce are of agricultural and horticultural origin, and

the necessity of securing purity and conformity to standards in articles of this kind is evident. Dangerous narcotics and poisonous substances should not be indiscriminately sold, and drugs intended for ordinary therapeutical purposes should conform to the standards laid down by competent authorities.

Work for Other Departments.

The Bureau of Chemistry is constantly increasing the services rendered to other Departments of the Government. This is especially true in respect of its collaborative work with the Treasury Department in controlling the polarizations of sugars, and in assisting the appraisers in the classification of other imported articles where the rate of duty depends upon chemical and physical characters.

Extensive studies have also been conducted for the Post-Office Department in regard to the character of canceling inks and stamps used therewith. Similar investigations have been conducted for the Bureau of Engraving and Printing in regard to colors used for printing bank notes, bonds, and other Government securities.

All of this work is of a nature which is highly important to the public service, and is conducted largely on agricultural products.

DIVISION OF ENTOMOLOGY.

Work on Insects from Abroad.

THE SAN JOSE SCALE AND ITS ASIATIC LADYBIRD ENEMY.

In the report of last year attention was called to the exploration which was being conducted by the First Assistant Entomologist, Mr. Marlatt, in Japan and China, to discover, if possible, the native home of the San Jose scale (*Aspidiotus perniciosus*), and also to find native parasites and enemies which might be imported to control or at least check the damage which is done by this insect in the deciduous orchards of this country. Mr. Marlatt's exploration of Japan demonstrated that the San Jose scale is not a native of that country, as many of our entomologists had supposed, but, on the contrary, that it had come to Japan comparatively recently on imported nursery stock, and been thus spread somewhat generally over the islands of the Japanese Empire. Subsequent to the time covered by the report for 1901, viz, in the late summer and fall of that year, Mr. Marlatt extended his explorations to China, examining the coast region from Shanghai northward to Pekin. The evidence from native fruits and wild plants in the region about Pekin and south of the Great Wall established very clearly that the original home of the San Jose scale was in this region.

In brief, this scale insect was found on wild haw apples, native

crab apples, and native pears grown in the region indicated where no foreign fruit stock had ever been introduced. Furthermore, it was found in scattering numbers everywhere, just as one would expect in the native home of a pest of this sort where it is normally kept in check by natural enemies. There can be no doubt that at last its original home has been located. It was probably brought to America many years ago on imported Chinese flowering peaches or some other ornamental or flowering shrub from this region, having first appeared in the gardens of a great importer of ornamental and other plants in San Jose, Cal. A very interesting fact in connection with this discovery was the finding in this same region of a ladybird which preys on the scale insect naturally and seems to be the principal agent in preventing its often becoming very abundant and injurious. This ladybird (*Chilocorus similis*), a European and Asiatic species, in China feeds naturally on the San Jose scale and related forms, as also on the white peach scale, a very troublesome pest, which has recently gained foothold in our Eastern and Southern States. Several shipments of this beetle were made by Mr. Marlatt, some from Japan and some from China. Unfortunately, all perished but two, this mortality resulting from the long confinement of the six or seven weeks' trip from Asia and the unfavorable conditions under which they were kept in Washington during the winter.

From the two surviving individuals more than 2,000 beetles and larvæ are now on scale-covered trees on the Department grounds. In addition to these, shipments of some thousand beetles have been already made to other points in the East, a number of experiment station entomologists having expressed a desire to assist in the work of propagating, distributing, and establishing this useful ladybird. This importation promises most flattering results at present. It is, however, still an experiment, and what the ultimate benefit will be can only be determined after a two or three years' test. We hope to establish this ladybird in this country and to get from it some of the good results, at least, which it evidently accomplishes in China and Japan. It probably will not render it unnecessary in the future to occasionally spray or otherwise treat infested trees in commercial orchards, but it probably will be of very great assistance in keeping in check the San Jose scale in the thousands of gardens and small orchards of individuals who have no commercial interest at stake and who would not, ordinarily, take any means to keep this scale insect from multiplying on their trees, thus forming centers for contagion.

IMPORTATIONS OF OTHER BENEFICIAL INSECTS.

The preliminary attempts to introduce the European enemies of the gipsy moth have been continued. The difficulties attending the importation of the predaceous beetles from Europe to America are consid-

erable, and to get them established in this country will demand the careful cooperation of agents or interested individuals on the other side.

The black scale of the orange is the most destructive, perhaps, of all the orange pests in California, and the South African parasite of this scale insect, which we have been endeavoring to establish in California for the last year or two, still gives promise of ultimately becoming a fixture and doing the good service in our Western orange districts which it now does in South Africa and in Italy. The history of this importation was given in my report of last year. A recent letter from Mr. Alexander Craw, who is looking out for this experiment in California, reports that the parasite is breeding abundantly. With a beginning of only two female insects kept in captivity, he had sent out to different localities up to July of this year (1902) 25 colonies.

The very important European parasite of the larger scale insects such as the Lecaniums and mealy bugs (*Erastria scitula*) seems on the way to be successfully established in California. It is believed that the introduction of this insect into our citrus and olive districts will be of the greatest advantage to the growers of these fruits. With the cooperation of Mr. Craw, the horticultural quarantine officer, and Mr. Ehrhorn, of Santa Clara, these insects have already been liberated in Santa Clara, Los Angeles, and Niles, Cal., and the outcome of this effort at the introduction of a useful insect will be watched with interest, and the utmost care will be taken to bring it to a successful issue.

Another foreign insect promising great usefulness in a different direction, imported during the past year, is the European ladybird (*Coccinella septempunctata*) sent from Hungary through the kindness of Professor Sajo. These ladybirds feed on plant lice, and should be an efficient aid in controlling the destructive insects of this class which infest cotton, peas, melons, and other vegetables, and the fruits. Some of these insects have been sent to Mr. Craw, in California, where they give promise of becoming established; others to various Eastern experiment station entomologists, and they have also been colonized in the District of Columbia. Another ladybird (*Leis conformis*), a plant-lice feeder also, was imported from Italy and liberated in California. A further importation of this species may be necessary to effect its establishment here.

This entomological work of an international character has not been altogether one-sided. In other words, while we have been importing foreign insects and have been receiving a good deal of gratuitous assistance by entomologists abroad in this work, we have paid our debts, to a certain extent, by sending to foreign countries some of our beneficial insects. The extraordinary success in preventing damage from the white scale, once a great orange pest in California, by the introduction of the Australian ladybird, has been duplicated, as made evident

in former reports, in many foreign lands, notably South Africa, Portugal, and Egypt. During the last year colonies were sent from California, at our request, to Dr. Antonio Berlese, Portici, Italy, where this same white scale had established itself. Recent reports indicate that this exportation has proved to be another of the series of successes which has attended this insect wherever it has been sent to work against its notable scale-insect host. A colony of this ladybird has recently been sent, by request of the local board of agriculture, to Papeiti, Society Islands. We have also had sent, through the kindness of Mr. Craw, various beneficial ladybirds to the Bermuda Islands to assist in keeping in check the noxious scale insects occurring on those islands.

The South African Grasshopper Fungus.

The report of last year noted the beginning of an experiment to determine the effectiveness of the African grasshopper fungus as a means of destroying various forms of destructive locusts. The experiment has been continued the present year and much extended, the intention being to give this fungus a thorough and practical test to demonstrate whether it can really be counted on as a means of controlling the locust or not. The number of experimenters last year during the entire season was 223. During the summer of 1902 cultures of the fungus were sent to nearly 1,000 individuals, not including the perhaps even greater number of cultures which have been locally prepared by various individuals, and especially by Prof. C. P. Gillette, of the Colorado State Agricultural College, who has taken charge of the culture preparations and their distribution in his State. These cultures have been sent out to 25 different States and Territories. Results have not yet been tabulated, but some successes have been reported. It now seems probable that very great reliance can not be placed on this fungous disease. Either it does not work with our grasshoppers as readily as it does with the South African locust or our climate makes our species of grasshopper more resistant or the fungus less operative.

The Fig Fertilizing Insect.

As a further report of progress on the introduction and establishment of the fig-fertilizing insect in California referred to in previous reports and especially summarized in the report for 1901, it may be said for the year 1902 that thousands of figs containing the insects successfully withstood the winter climate of California, and an unlimited amount of fig insects was available at the proper time for caprification in the spring of 1902, resulting in the production of some 50 tons of Smyrna figs in the sole commercial orchard in existence at present, that of Mr. George C. Roeding, at Fresno. It was further found that

the fig insect successfully hibernates at Niles, Cal., and there is now no longer any danger of its dying out. In other words, the entomological problem of Smyrna fig culture in America is solved, and what remains to be done belongs rather to the domain of horticulture, namely, the introduction of more caprifig trees, improvement in the methods of curing and drying the fruit, and the determination of the regions throughout the arid West suitable to the industry. The practical success of Smyrna fig culture in California is now only a matter of time. In a very few years Smyrna fig orchards will be in bearing in many places in California and doubtless in other Western States where climatic conditions are favorable.

As stated in the report for 1901, Mr. Roeding spent nearly a year in Smyrna studying the methods of fig culture in that country under a commission from this Department. Much valuable data was obtained, for the most part appertaining to the horticultural side of the problem. The future of this industry, which promises to be one of the great ones of the arid region of the West, becomes more promising every year.

Work on the Mexican Cotton Boll Weevil.

The work on the Mexican cotton boll weevil reported in 1901 has been continued, and has the present season been given a very practical status by means of the specific appropriation by Congress for the purpose of $20,000. A field experiment is being conducted on two cotton plantations, one of 200 and the other of 125 acres, under the control and direct management of the Entomologist, to demonstrate that by proper methods the damage from the boll weevil can be so reduced as not to be a serious menace to the production of this important staple in the region in Texas already invaded by the weevil.

In spite of the delayed beginning this year, owing to the late date at which the appropriation was available, the entomological side of this field experiment has been thoroughly successful, and the weevil has been practically eliminated from the plantations under Departmental control. The cotton season, however, in Texas has been the most disastrous one climatically in twenty-five years, and this will prevent the cotton yield on these plantations coming up to the average, the lessened yield, however, in no wise being chargeable to the boll weevil. It is urged that the means for continuing this investigation be provided, as it is one of the very greatest importance for the whole cotton industry of the South. There can be very little doubt but that ultimately the Mexican boll weevil will spread to the adjoining State of Louisiana, and thence across the cotton belt east of the Mississippi, and is capable of becoming one of the most destructive insects in America. If, on the other hand, the Department can demonstrate by practical field work that the weevil can be controlled, as indicated by

the preliminary experiment this year, it will have the effect of influencing planters generally, in Texas and elsewhere, to adopt the same methods, and thus avoid much of the loss which this insect threatens.

In this connection, reference may be made to the Egyptian cotton which, by newspaper report and otherwise, has been somewhat exploited as immune to the boll weevil. This misconception is capable of doing harm, inasmuch as the Egyptian cotton is rather more subject to weevil damage than the variety of cotton ordinarily grown in Texas. In a field of Egyptian cotton near San Antonio practically every square was punctured by December 12, and the weevils had begun to attack the bolls, half of which had at that date been destroyed. The fact that Egyptian cotton seems to be later in maturing than the smaller American plant causes it to be much more liable to damage by the boll weevil. The same conditions with Egyptian cotton were also noted on another plantation.

In the fall of 1902, after the close of the active field work of the season, the agent in charge made some very desirable explorations in Mexico, more especially to investigate the subject of natural enemies. Important biological and life history studies have been prosecuted in Texas and the present range of the insect has been carefully mapped.

Work on the Codling Moth in the Northwest.

The work done on the codling moth in the Northwest has been continued with very satisfactory results. A detailed report of this work has been published. The work the present year has been of a very practical character, a successful orchard demonstration having been conducted which showed that it is possible to prevent much of the damage which is now annually suffered from the codling moth.

Work on Insects Damaging Forests.

During the first half of the year several important investigations were made of forest insect depredations by Dr. A. D. Hopkins, of the West Virginia experiment station, who was employed at the request of Mr. Gifford Pinchot, of the Bureau of Forestry, as a temporary agent of the Division of Entomology for the purpose. Great loss of pine timber, to the amount of more than 600,000,000 feet (board measure) in the Black Hills Forest Reserve, has resulted from the work of a bark-beetle mining under the bark of living trees. Numerous facts have been determined relative to the life history of this insect, and it has been possible to detail practical methods, the adoption of which will largely decrease future losses. A report of this investigation has been published.

Another investigation was of hickory and other forest trees near Geneseo, N. Y. The hickories had been killed by a bark beetle, the damage having already gone beyond repair for most of the region

invaded. Had an earlier report of the difficulty been made to the office, a prompt application of known methods of control would have prevented this loss. A special report of this investigation will soon be published. The damage occasioned by this hickory bark beetle seems to be quite general throughout the Northern United States, and will receive considerable attention in the future, especially now that Dr. Hopkins has been regularly appointed to the Division of Entomology as expert in forestry insects. A study of the insect enemies of Eastern, Southern, and Western pine forests has been begun to determine, if possible, the primary causes of the serious insect damage now being done to pine timber of western North and South Carolina, northern Georgia and southern Florida, the white pine or silver pine of the Pacific slope, the Monterey pine, California, and the pines of Arizona and Colorado. The regions designated have been given a preliminary survey to determine existing conditions, and it is expected that by the close of the next fiscal year it will be possible to have a report ready for publication on the principal pine insects of North America, which will include brief popular descriptions of the more important insects, with illustrations, and recommendations for preventing losses.

Work on Scale Insects.

The important work of the year on scale insects has been the investigation of the San Jose scale in China and Japan, referred to under "Work on insects from abroad." The experimental work on the San Jose scale at home has been continued, and a circular (No. 42) describing the methods of controlling this insect has been revised to include the results of the latest information on methods of treatment.

The Division of Entomology of this Department is looked upon as the chief source of information upon scale insects, few of the experiment stations having collections or literature sufficient to enable the determination of specimens; hence much work is done every year in determining material for station entomologists and for private individuals throughout the country. In addition, many large collections of scale insects have been received for study and determination from foreign countries, notably from Australia, New Zealand, the Bermudas, and Italy.

In the course of the trip of exploration made by Mr. Marlatt in Japan and China, Java, and other countries in the Orient, a particular study was made of the scale enemies of citrus and other fruit trees, and large collections of this class of pests were brought home from the countries visited. The knowledge gained from this study will be of great practical importance. It will acquaint us with the scale pests of these countries, which are being brought into closer commercial relations with the United States, a knowledge which is desirable because these

insects are more apt in the future than in the past to reach our shores through importations of fruit trees and ornamental stock. The scale insects of foreign countries are perhaps the most important pests to be considered in all quarantine and other operations looking to the protection of our growers from foreign invasions, since these insects live for the most part attached to the bark of trees and are much more apt to be brought in with plants than are other insects.

Insects Injurious to Shade Trees.

Many complaints of insects affecting shade trees have been received in recent years, and among these are several important foreign species, which have been under investigation during the year.

Insects Injurious to Truck Crops.

The studies already under way on destructive insects affecting truck crops have been actively followed up, and an extensive report on the principal insects that have recently been injurious to vegetable crops has recently been issued. A number of insects injurious to leguminous food crops received considerable attention, and the new facts discovered in the life histories of some of them are of value in suggesting means of control.

Work on Insects Injurious to Stored Products.

Certain insects of this class are increasing their ravages. The Mediterranean flour moth, which is the most troublesome of all insects that are harmful in flouring mills, was reported as injurious in mills in new localities in California, and in Michigan, Wisconsin, and Minnesota. The Angoumois grain moth has also increased in injuriousness in a number of States, particularly northward and in California.

The cigarette beetle has been very destructive during the past season. Thorough investigations were conducted with a view to find a remedy for this pest, and much of value was learned and published.

An exotic cabinet beetle did much injury to silk in New Jersey and to domestic tanned leather in New York City, its introduction being traceable to the introduction of foreign hides. In the treatment of the insects which affect stored products, recent experiments with hydrocyanic-acid gas indicate that this remedy may, in course of time, be found more valuable than the bisulphide of carbon usually employed in the treatment of many such insects.

Work on Insects in their Direct Relation to the Health of Man.

Insects as conveyers of disease to human beings have been the subject of special research by the Entomologist for the past three years. A popular article on this topic was published in the Yearbook for

1901, and has since been reprinted in more popular form. During the past summer many inquiries have been received requesting information and advice on the subject of mosquito and fly control, and these have been answered by the publication in question and by specific advice. This investigation is being actively prosecuted; the field is a very large one and of the greatest importance. While perhaps the principal insects responsible for the transmission of disease have received study, there remains very much yet to be learned of them, and, furthermore, the Entomologist is in frequent receipt of new material from this and other countries, and is constantly discovering new facts bearing on this general problem.

UNCLASSIFIED WORK ON INJURIOUS INSECTS.

During the fiscal year investigations were taken up on supposed insect damage to cocoanut and other palms in Cuba, Florida, and in British Honduras. An article on the principal insects which act as disseminators of the trouble locally termed "fever," and due to a fungous disease, includes suggestions for methods of prevention of the dissemination of the disease.

INSECT DETERMINATIONS.

An important line of work is the identification and maintenance of records of the habits of injurious insects received from correspondents, field agents, and others to serve as a basis for determining the best means of controlling them. During the fiscal year 226 species not hitherto studied at this Department received more or less attention, and the catalogue number of biological series thus studied now reaches 9,667.

The time of two expert assistant entomologists and several minor assistants and aids is devoted to the preparation of material for permanent storage in the United States National Museum, for exchange with other institutions, and for illustration and description.

EXPERIMENTAL WORK WITH INSECTICIDES.

During the year a considerable number of experiments with insecticides and other methods of controlling insect depredations have been conducted. A great many insecticide substances are constantly being advertised, and many of them are sent to the Entomologist for experimental examination and test either from purchasers or the manufacturers. Most of these are of very little value, or are combinations of old and well-known insecticide substances, sold, however, as a rule, under their new form at many times their real cost. The assistance of the Chemist has been invoked to determine the composition of these substances, and he has recently established a special section for insec-

ticide analysis and investigation in cooperation with the Division of Entomology.

To determine the feasibility of eradicating household insects by fumigation with hydrocyanic-acid gas several valuable experimental operations have been conducted, with the result of the establishment of the complete practicability of disinfecting houses by this means. This poisonous gas can be used without risk to human life if the operation is carried on with proper precautions, but no one is advised to undertake it without having fully acquainted himself with the steps in the process as indicated in Circular No. 46 of the Entomologist's office.

Silk Investigations.

The silk investigations authorized by the last Congress have been placed in the charge of the Entomologist. Miss Henrietta A. Kelly has been employed as special agent in silk culture in the South, and is charged with the preparation of a manual of instructions which it is expected will be ready for publication and distribution this fall. She will also look over the ground and select suitable locations for model silk plantations and rearing establishments which may serve as schools of instruction where interested persons and others may come and acquire familiarity with all the steps in the care of caterpillars and the handling of cocoons. The Entomologist, Dr. Howard, during the summer made a careful examination of the silk industry of southern France and of Italy, studying especially the methods of reeling silk, and silk manufacturing establishments, mulberry culture, and breeding methods. He has also arranged for the purchase of "seed" or silkworm eggs which can be relied upon as free from disease, and has negotiated for the importation of desirable mulberry stock. It is the intention to follow up this investigation by establishing experimental stations in the South, by cooperative work with some of the agricultural experiment stations which have expressed the wish to assist us in the investigation of silk culture, and also to establish at some suitable point a practicable reeling plant so that the silk cocoons produced in small quantities may be purchased and reeled and the product marketed.

Apicultural Investigations.

In apiculture the work has included an importation of select breeding queens from Italy and smaller importations from Austria and Cyprus. These were forwarded to experiment stations and to bee raisers in different sections of the country. Very favorable reports from these queens have been received, notably from southern California, where, it was stated, while black bees were doing nothing, the Cyprians from the Department importation gathered a fair crop, double the yield also of the best Italians. Various crosses were made

between these races and some promising strains secured, one result being that the irritability of some excellent honey gatherers can be modified by using males of gentler races in the crosses.

DIVISION OF BIOLOGICAL SURVEY.

The Biological Survey is charged by Congress with three distinct lines of investigation, each of which is organized as an independent section of coordinate value with the ordinary Departmental division. The first, or Biological Survey proper, studies the geographical distribution of mammals, birds, and plants with reference to the climatic factors governing distribution, and from this study prepares maps showing the boundaries of the natural life zones and crop belts of the country; the second, or Section of Economic Ornithology, studies the food and food habits of birds with relation to agriculture and horticulture; the third deals with matters of game preservation and introduction.

Biological Survey.

California and Texas, owing to their great size, the diversity and commercial value of their agricultural products, and their promise of far greater development in future, have unusual claims on the Biological Survey. In California the work is peculiarly difficult by reason of the extraordinary diversity of the topography and climatic conditions. Not only are there torrid valleys below the level of the sea, and alpine summits towering to elevations above the limit of plant growth; there are also areas of excessive humidity, of frequent fogs and heavy rainfall, and areas of excessive aridity, hotter and drier than the Sahara, where perpetual sunshine is the rule and years sometimes pass without rain.

Owing to the trend of the principal mountains and the influence of the coast fogs, the zones run in the main north and south instead of east and west. Some of the large interior valleys, notably the Salinas, act as flues through which a great volume of fog flows daily at certain seasons, lowering the temperature and increasing the humidity for a distance of 75 miles or more. These great rivers of fog cut off the sun, lower the temperature, and increase the humidity, and by overflowing through canyons and side valleys also reach and exert their influence in numerous tributary valleys and basins, some of which lie between the main fog river and the coast. In these cases the usual conditions are reversed, for ordinarily the valleys of the coast ranges in retreating from the sea toward the interior receive less and less fog and more and more heat and sunshine. Each valley and each mountain slope therefore has its own climatic individuality and its own capacity or adaptability for particular agricultural and horticultural crops. Some are cool enough for apples, cherries, and the sugar beet;

others warm enough for almonds, raisin grapes, and citrus fruits. And in the case of some of those in which the same crops may be cultivated with equal success, these crops mature at widely different dates. Thus oranges ripen in southern California from January to April; on the Santa Barbara plain, in July and August; at Oroville, in November and December. Similarly, peaches mature at different points in northern California from May to September, and in Los Angeles as late as November. Cherries are ready for market in Vaca Valley in March and April, while in neighboring valleys they do not ripen until May and June. The great commercial importance of these differences in time of ripening of fruits is obvious.

The native fauna and flora of a region afford a suggestion as to its climatic peculiarities and agricultural possibilities, assisting one to conclude what farm crops and varieties of fruit will or will not be likely to succeed in a particular place. The Biological Survey is making a critical study of this subject, and is engaged in the preparation of maps showing the natural distribution of the faunal and floral areas and consequent courses of the crop belts, and is also preparing lists of the particular kinds and varieties of crops and fruits likely to succeed in each. The labor of tracing the zone boundaries in California is one of infinite detail, and is rendered still more difficult by the absence of accurate topographic base maps, except of the areas already mapped by the United States Geological Survey.

In addition to the work in California and Texas, some field work has been done in Montana, the Dakotas, Nebraska, Kansas, Indian Territory, New Mexico, Mexico, and Canada.

THE PRAIRIE DOG SCOURGE.

The extension of ranching on the Great Plains has led to serious, widespread, and reiterated complaints of steadily increasing losses from the depredations of prairie dogs. The increase in these pests is the natural result of the destruction of their enemies, chiefly coyotes and the larger hawks. Assistants were sent to various points in the afflicted area, from Montana to Texas, and much information was collected. As a result a circular of directions for the destruction of prairie dogs has been published, and an article on the subject was contributed to the Yearbook for 1901.

SECTION OF ECONOMIC ORNITHOLOGY.

During the year field work on the food habits of birds has been carried on in California and Maryland, and the stomachs of considerably more than 2,000 birds have been examined in the laboratory. Of these, 1,000 were of the game birds, 500 of sparrows, and the remainder distributed among other groups of economic value. A bulletin on

the food of sparrows has been published, one on the food of game birds is well advanced, and one including the results of an extended economic study of birds on a Maryland farm has gone to press.

For many years California fruit growers have complained of the destruction of buds and fruit by birds. In order to gain definite knowledge on this subject, the chief of the section was sent to California, where he spent several months studying the food habits of birds in the great fruit-growing districts. Besides observing the food habits and collecting the stomachs of birds killed in the fruit trees, he noted and collected the kinds of wild fruits and seeds, and also the insects found in the immediate neighborhood of the orchards, for aid in identifying the stomach contents of the birds.

Section of Game Protection and Preservation.

Work under the Lacey Act has been continued along three principal lines: (1) Publication of information on game protection; (2) improvement in the inspection service guarding the importation of foreign birds and mammals; (3) cooperation in restricting illegal interstate shipment of game.

Compilations and synopses of game laws have been issued and widely distributed, and are in constant demand. Among the most popular and useful of these are digests of the game laws and of the laws protecting nongame birds for the current year. An annual directory of State officials and organizations dealing with matters of game protection was also published.

During the year 287 permits were issued for the entry of about 200 mammals and 50,000 birds. The imported birds may be classed under two heads—game birds introduced for propagation and birds bought to supply the trade in cage birds. The latter greatly exceed the former in number. The inspection service, which now includes the principal ports of entry of both coasts, and also Honolulu, Hawaii, is now maintained by fees paid by the importers. Importers complain of this, and the Department would be glad to place the inspection service on a permanent basis should Congress make the necessary appropriation. By strict economy the service could be maintained at the three most important ports of entry at a total cost of $1,000 per annum.

DIVISION OF STATISTICS.

The work of the Division of Statistics has been continued on the usual lines. With a view to further improving its crop-reporting service two additional field agents have been appointed, and the statistical expert who has for some years had charge of the crop statistics of foreign countries competing with the United States has been sent to London, England, where he is in closer touch with the statistical offices of

the different European Governments, whose reports, along with the most authoritative commercial intelligence of interest to American agriculturists, he transmits to Washington by mail or cable from time to time.

In cooperation with the State Agricultural College of Minnesota a statistical investigation is being conducted by the Division of Statistics into methods of farming, the results of which will have an important bearing on such questions as the relative profitableness of crops, the economical utilization of farm labor, etc.

The work of this Division will shortly form the subject of a special report to Congress.

OFFICE OF EXPERIMENT STATIONS.

Development of the Work of the Office.

The functions of the Office of Experiment Stations have been enlarged in several directions during the past year, and the enterprises previously in its charge have become more extensive. Especial efforts have been made to aid the movement for the strengthening of agricultural education and research through the more definite formulation of agricultural science and the more thorough training of agricultural experts. For this purpose the work of this Office, in connection with the Graduate School of Agriculture, as described elsewhere in this report, has proved to be unusually successful and effective. Attempts have also been made to call the attention of the agricultural public and the managers of educational systems to the great desirability of making agricultural subjects a part of the curriculum of secondary and elementary schools. The development of the farmers' institutes as effective agencies for the dissemination of the results of the work of this Department and the experiment stations has also received attention. The agricultural experiment stations under the direct management of this Office in Alaska, Hawaii, and Porto Rico have been put upon a firm basis, and much progress has been made in developing useful lines of work in these regions.

The Office has been brought into closer relations with the institutions for agricultural research in foreign countries through work involved in the preparation of a bulletin setting forth the organization, resources, and lines of work of these institutions. By this means our knowledge of these foreign institutions has been greatly broadened, and it will be more feasible hereafter to secure definite information regarding their work which will be useful to similar institutions in this country. Both the legal and engineering features of the irrigation investigations have been enlarged, and a beginning has been made of investigations in other lines of agricultural engineering which have hitherto been neglected by this Department. Improvements

have been made in the apparatus and methods for nutrition investigations. The results of these investigations have been more effectively brought to the attention of teachers of physiology and domestic science, and beginnings have been made of what it is hoped may develop a systematic study of dietaries in public institutions.

With the expansion of its work the amount of useful material prepared for publication in this Office has materially increased. Special efforts have been made during the past year to publish this material in forms which will contribute to its effective and economical distribution. The performance of duties growing out of the relations of the Department with the Civil Service Commission has also involved considerable work. With the constant and rapid growth of the system of agricultural education and research in this and other countries the general business of the Office in its relations with outside institutions is necessarily enlarged from year to year.

Progress of the Experiment Stations.

The feature of the progress of agricultural institutions in this country which has attracted most attention during the past year is the rapid increase in the public interest in these institutions. This is shown in the increase in the number of students in agricultural colleges and schools, in the larger attendance at the farmers' institutes, in the enlarged correspondence and mailing lists of the stations, in the increased demand for trained workers in agricultural and other business enterprises requiring scientific and expert knowledge and skill for their most successful management, and in the wider space given to agricultural education and research in agricultural and other journals.

During the year a number of new institutions for investigations in agriculture have been established in different States. The State legislatures have continued to be very liberal with the agricultural colleges and experiment stations. Over half a million dollars annually are now contributed by the States to the maintenance of the experiment stations.

Evidences of the influence of station work in improving agricultural practice and benefiting the farming interests of the country continue to multiply. This influence is felt in all of the various phases of agricultural operations. It is possible here to briefly refer to only a few recent examples of the practical benefits which are being derived from investigations by the experiment stations.

The origination and introduction of improved varieties of cereals through the agency of the stations of the grain-growing region, cooperating with this Department, is resulting in a vast increase of the grain-producing capacity of the country. As an illustration of this it may be cited that a variety of oats imported by the Department and

tested and improved by the Wisconsin station, among others, has been widely distributed and grown, with results which indicate that its general introduction will be followed by an average increase of yield which may be safely estimated at from 3 to 5 bushels per acre. As the acreage of oats in Wisconsin alone in 1901 was, according to our Statistician, 2,290,288, producing 66,647,381 bushels, worth $25,992,479, this would mean a gain to the farmers of Wisconsin annually of from $2,400,000 to $4,400,000 on the oat crop alone.

Marked improvement in the yield and quality of wheat in the Northwestern States is resulting from the distribution of improved varieties originated by the Minnesota station. One of the results of the work of the Illinois station on the breeding of corn has been the formation of the Illinois Seed Corn Breeders' Association, a chartered organization, with a limited membership of reputable and well-known corn growers, pledged to select and grow their seed corn according to definite rules formulated by the station and to sell only their own crop. The success of this enterprise has been phenomenal. All of the available supply of the improved seed is rapidly disposed of to farmers and much of it is engaged in advance. The work of this station on corn is proving to be far-reaching in its results, not only in improving the general quality of seed corn, but in inducing practical men to undertake breeding for special qualities—for protein, for oil, or for starch—which the station has demonstrated to be entirely feasible. The influence of station investigations is also being widely exerted in the grain-growing region in the introduction of rotations to conserve soil fertility in place of the exhaustive system of continuous grain cropping heretofore generally followed.

The beneficial effects of the work of the stations in the older States on fertilizers are becoming every year more apparent in the economical purchase and intelligent use of fertilizers by farmers. For example, as a direct result of the investigations and advice of the New Jersey station, organizations of farmers have been formed in the truck-growing districts of that State for the purchase of unmixed fertilizing materials, thus effecting a saving of from 25 to 40 per cent in the cost of their fertilizers, and at the same time securing better results as regards earliness, yield, and quality of product.

The recent introduction into a number of States of a system of inspection by the stations of feeding stuffs, similar to that which has been in force for some time for fertilizers, furnishes a very effective means of protecting farmers against fraud and of inculcating correct ideas regarding feeds and feeding. It is encouraging to note that in many States farmers are now following very closely the advice of the stations regarding the purchase of concentrated feeds and the balancing of rations made from home-grown products.

The rapid extension of the rational use of silage and the very

general adoption of the round form of silo is directly traceable to experiment station influence.

Through the efforts of the Department and the stations, the application of insecticides and fungicides as means of protection against injurious insects and plant diseases has become almost universal, and the benefits and profits resulting from the practice are no longer questioned. Striking evidence of the readiness with which farmers and fruit growers will now adopt promising means of plant protection is furnished by the fact that the method of formaldehyde treatment of smut of oats, proposed by one of the stations, was almost immediately put into use by over 25,000 farmers in the State of Wisconsin alone, with the prospect that the number using the method will be vastly increased the next year. As the estimated loss from oat smut in Wisconsin varies from $3,000,000 to $7,000,000 annually, according to the season and other conditions, the value of an effective means of prevention of the disease can be readily estimated.

The Utah station has achieved notable success in its study of the extent to which dry farming, that is, farming on lands in the arid region which can not be irrigated, may be practiced with profit and the conditions necessary to success. This work is bearing fruit in the rapid extension on a safe basis of what has heretofore been a very precarious system.

So rapidly has the demand for the services of agricultural experts spread in different directions that the workers in this service have in many instances been overworked, or, at least, have been forced to dissipate their energies in attempts to cover too many fields. There is, therefore, a most urgent necessity that the number of workers in our agricultural institutions should be increased so as to permit proper specialization of work. The station investigators must be relieved of teaching, lecturing at farmers' institutes, and other services, which, while important in themselves, distract their attention, dissipate their energies, and seriously hinder the progress of effective investigations.

It will be of little use to construct expensive laboratories and equip them with elaborate apparatus unless they are manned with first-class investigators. There is nothing new in this proposition, but the progress of agricultural institutions in this country in recent years makes it imperative that the work of the experiment stations and of this Department as the source of new knowledge on agricultural problems should be raised to the highest grade and kept there. The wider the work of the agricultural colleges, schools, farmers' institutes, and other agencies for the education of our rural population becomes the more important is it that the institutions of research in agriculture should be the best that human wisdom can devise. It is now necessary to insist on this more strongly than ever before, and it will be necessary to reiterate it until the managers of agricultural institutions and

the friends of agricultural progress accept this principle in practice as well as in theory. Under present conditions a large number of the experiment-station workers are attempting too many different kinds of work, and the progress of the station is seriously hindered from this cause.

One result of the lack of a sufficient number of well-trained and experienced workers in our agricultural institutions is that the best men are constantly being shifted from one institution to another or are departing to outside enterprises offering larger salaries and other attractions. The past year has witnessed an unusually large number of such changes in the personnel of the experiment stations. This is a very serious matter, since the time element in the conduct of agricultural investigations is an important one. Until the tenure of office in our stations is much more stable than at present we must expect that there will be much waste of work and funds in incomplete investigations due to the frequent shifting of the officers in charge. There is also need of increased funds for the general expenses connected with agricultural investigations.

Cooperation of the Stations with the Department.

During the past year many cooperative enterprises between the different Bureaus and Divisions of this Department and the experiment stations have been continued and contracts have been made for a considerable number of new investigations on this plan. In order to more clearly define the conditions under which such cooperative arrangements should be made a plan was formulated for conducting this work and transmitted to the directors of stations as well as to the chiefs of Bureaus and Divisions of the Department. This has cleared away some difficulties hitherto attending arrangements with the stations, and especially has defined the responsibilities of both the Department and stations in such enterprises.

The work undertaken conjointly with the stations is of the most varied character, but under the system devised there is no friction, and it is believed that much good will result to both the Department and the stations by this close union of interests. In all cases the general policy is to bring about a definite and clear understanding regarding the responsibilities of the Department and the stations, and when this is accomplished the carrying out of the details is a comparatively simple matter. The Department is not concerned with local State problems, but there are questions not bounded by State lines which the Department can take up, and which, with the cooperation of one or more stations, should be earnestly investigated. In this way the Department becomes the medium for the combining of interests in a way that will be helpful to all.

Graduate School of Agriculture.

A new enterprise in agricultural education has been inaugurated by the establishment of the Graduate School of Agriculture, which held a four weeks' session during the month of July, 1902, at the Ohio State University, Columbus, Ohio. The plan for this school was originated by Prof. Thomas F. Hunt, dean of the college of agriculture and domestic science of the Ohio State University, the purpose being to establish a school for advanced students of agriculture at which leading teachers and investigators of the agricultural colleges and experiment stations and this Department should present in some regular way summaries of the recent progress of agricultural science, illustrate improved methods of teaching agricultural subjects, and afford a somewhat extended opportunity for the discussion of live topics drawn from the rapidly advancing science of agriculture. This idea received the cordial support of President Thompson of the Ohio State University, and on the recommendations of these two men the board of trustees of the university voted to establish such a school and generously made provision for the financial support of its first session.

The Association of American Agricultural Colleges and Experiment Stations at its convention in 1901 favored the plan for the school and voted that, if the success of the first session seemed to justify its continuance, it be made a cooperative enterprise under the control of the association. Believing this movement to be in line with the objects for which this Department was created, I gave it my cordial approval, and on my advice the Director of the Office of Experiment Stations consented to act as dean, and other officers of the Department of Agriculture to be members of its faculty. Under these favorable auspices there was little difficulty in securing a strong faculty. As actually organized, this included 35 men, of whom 26 are professors in agricultural colleges, 7 are leading officers of the Department of Agriculture, and 2 are officers of the New York State experiment station. Courses were offered in agronomy, zootechny, dairying, and breeding of plants and animals. The school was housed in the substantial and well-equipped agricultural building of the Ohio State University, where were illustrated the most improved apparatus of instruction in soil physics, dairying, and other agricultural subjects. Besides the live stock of the university farm, leading breeders of Ohio furnished choice animals for the stock-judging exercises.

General problems of agricultural science and pedagogy were discussed at the inaugural exercises and at Saturday morning conferences. Among the topics thus treated were the history of agricultural education and research in the United States; the organization of agricultural education in colleges, secondary schools, nature-study courses, correspondence courses, farmers' institutes, and various forms of

university extension; what constitutes a science of agriculture; methods and values of cooperative experiments. Through social assemblies, visits to typical Ohio farms, and much informal discussion wherever the students met each other, the educational influences of the school were greatly extended. Seventy-five students were in attendance. These were drawn from 28 States and Territories, including such widely separated regions as Maine, Oregon, California, New Mexico, and Alabama. There was one student from Canada and one from Argentina. There was also one woman, and the colored race was represented by teachers from the Tuskegee Institute and the agricultural college at Greensboro, N. C. Twenty-seven of the students are professors or assistant professors of agriculture in agricultural colleges, 31 are assistants in the agricultural colleges and experiment stations, 9 are recent college graduates, and 8 are engaged in farming.

Considering the character of the faculty and students, it goes without saying that the whole period of the session was occupied with the most earnest and profitable work. Without doubt the influence of this school will be felt throughout the country in the improvement of courses of instruction in agriculture and the strengthening of the lines and methods of investigation of agricultural subjects. In other ways the school will exert a beneficial influence. So rapid has been the accumulation of materials for a real science of agriculture during the past few years that even professional students of agriculture have not realized how large a mass of knowledge is already available for molding into a systematic body of truth which may be utilized for pedagogic purposes, as well as for inductions of scientific and practical value. The summaries given by the experts gathered at this graduate school have emphasized this fact and shown in a striking manner that agricultural education and research may now be properly and efficiently organized with reference to the science of agriculture itself, rather than be as heretofore very largely a matter of the sciences related to agriculture. This will serve to stimulate greatly the movement already begun for the reduction of the materials of agricultural science to "pedagogic form" for use in colleges and secondary schools, and for the reorganization of agricultural institutions of research on the basis of the divisions and subdivisions of agriculture instead of physics, chemistry, botany, and other primary and secondary sciences. The day will thus be hastened when the science of agriculture will rank as one of the great systems of knowledge of direct benefit to mankind.

Improvement of Rural Schools.

We are, without doubt, in this country just on the edge of a great popular movement for the improvement of the conditions of rural life through the improvement of the rural schools. As one phase of this movement there will come the broadening of the instruction in the

principles of agriculture, so that in addition to college courses we shall have secondary courses in ordinary and special high schools, and even some elementary instruction in the common schools. In establishing the lines and methods of secondary and elementary instruction in agriculture so that it may be useful and attractive to the masses of our rural youth, the leaders in agricultural science gathered in the Graduate School of Agriculture this summer will play an important part, and it is believed that they have gone out from this school with much inspiration to renewed efforts in this direction. For both the thorough establishment of the science of agriculture and the wide popularization of this science, the new school will, it is believed, be an efficient agency, and I hope the way may open for it to become a permanent institution.

The Agricultural Colleges.

A number of the agricultural colleges have made considerable progress during the past year in strengthening and broadening their courses in agriculture. Specialists in agronomy, animal husbandry, soil physics, soil bacteriology, dairying, and other branches of the general subject of agriculture have been added to their faculties. This has made it possible to materially increase the number of different courses in agricultural subjects offered to their students. This is especially true of the short or special courses in agriculture for students who for one reason or another are not able to take the entire course leading to the bachelor's degree.

Statistics of attendance at the land-grant colleges for the year 1901 show that over 42,000 students were enrolled. This was an increase of nearly 7 per cent over the attendance for the previous year. The total attendance upon four-year courses in agriculture (including dairying) increased more than 26 per cent. The number of students in special courses has fallen off relatively, indicating a growing recognition of the greater value of the full collegiate course in agriculture as compared with specialization along narrow lines in undergraduate work.

During the past two years there has been a remarkable increase in the number of buildings erected at these colleges. It is estimated that during this period at least $2,000,000 have been spent by the States for this purpose. In these buildings there are not only improved facilities for instruction in the sciences related to agriculture, but also more particularly for the teaching of the different branches of the science of agriculture itself. The changes in equipment and in the organization of faculties have put college instruction in agriculture largely on a new basis. Since the new courses deal much more largely directly with agriculture, both as an art and a science, the students are not only well trained in the theory of agriculture, but are brought

much more closely into sympathy and actual contact with the practice of the art. Each year the chasm which formerly existed between science and practice is being more strongly bridged. Stronger bonds of sympathy and effort are uniting scientists and farmers through the medium of the agricultural institutions. The colleges therefore not only occupy a better position in the educational world, but they are also more strongly intrenched in the confidence and support of the great masses of practical men.

Secondary and Elementary Schools of Agriculture.

Institutions for secondary and elementary instruction in agriculture are becoming more numerous. Schools of this class already established have been continued, new schools are being established, and courses of instruction in agriculture, nature study, and gardening are being introduced into existing public and private schools. The marked success of the agricultural high schools established in connection with the universities of Minnesota and Nebraska indicates that there is a demand for agricultural courses of parallel degree with those offered in various manual arts in our city high schools. Already there is a promising movement for the establishment of special agricultural high schools in different localities separate from the colleges, and some instruction in agriculture is now given in a number of normal and public high schools. Students taking such high-school courses would undoubtedly be able to better appreciate the work of this Department and the agricultural experiment stations and would have a better outlook regarding the movements of our times for the improvement of agriculture, which would enable them to become intelligent, progressive, and successful farmers. All over our country farmers are sending their children to public high schools and paying tuition for their instruction. They have, therefore, good reason to urge that courses on subjects related to agriculture should be introduced into these schools, especially in towns which are wholly or largely dependent on the neighboring farms for their commercial success, if not their very existence.

Since the funds expended in promoting technical education in agriculture are in the nature of investments which will be richly repaid in larger amounts of assessable farm property and the increased wealth that comes from improved farm products, both the States and the local communities can well afford to make liberal contributions to the support of courses in agriculture in the secondary schools as well as in the agricultural colleges.

Progress is also being made in the movement for the consolidation of rural schools which has already resulted in improved conditions in the schools of Ohio, Massachusetts, Iowa, and other States. Such consolidation makes it possible to introduce nature study in which matters pertaining to agriculture, horticulture, and domestic arts are

easily included. Several States have already passed laws requiring teachers to prepare themselves to give instruction in nature study and agriculture, and exercises and illustrative material for such work are being more frequently published, often with the aid of the teachers in the agricultural colleges.

Another closely allied movement at present manifest principally in the city schools is the school-garden movement—the introduction of garden work with flowers and vegetables into the graded schools as a weekly or semiweekly exercise. Wherever work of this kind has been tried under proper supervision it has aroused considerable interest on the part of the students, has furnished excellent material for nature-study work, and has correlated well with the other studies in the curriculum.

Farmers' Institutes.

In my last annual report I recommended that an appropriation of $5,000 be given to enable the Office of Experiment Stations to undertake work connected with the promotion of the farmers' institute system in this country. The appropriation was to be used in employing an officer who would devote his time and energy to this work, visit institute workers and advise them regarding the ways in which the Department might help the institutes, study the problems of institute management at home and abroad, and seek to shape the Department's work for the institutes so that it might be most helpful to this enterprise. As the matter was finally fixed in the appropriation act, only about $2,000 of the income of the Office of Experiment Stations for the current fiscal year can be used for this purpose. This is entirely inadequate for the work planned, but will be used in gathering statistics of the institute movement and in employing, during a part of the year, an officer who will be retained as farmers' institute specialist, if Congress shall provide sufficient means for continuing the work.

Farmers' institutes are now held in 44 States and Territories, including Hawaii. Nearly complete returns from 40 States and Territories show that in the areas reported about 2,300 institutes are held annually; that the funds expended by the different States and Territories in support of these institutes (not including expenses incurred by local authorities) amounted to about $196,000 per annum, and that about 709,000 people attended the institutes. The number of students taking the agricultural course at the agricultural colleges in the same States and Territories during the year ended June 30, 1901, was 9,623, including those who are recorded as attending courses in household economy, dairying, and veterinary science.

The total number of persons reached by the farmers' institutes and the agricultural colleges (about 720,000) is, however, only a small percentage (7.2 per cent) of those actually engaged in agricultural pur-

suits (about 10,000,000). The publications of the experiment stations are sent to about 500,000 farmers. A great need of our educational system is, therefore, wider dissemination of the results of agricultural study and research among those now actually engaged in farming.

I recommend that an appropriation of $6,000 be made by Congress to enable the Office of Experiment Stations to aid the farmers' institutes during the fiscal year 1904.

Experiment Stations in Alaska.

Agricultural experiment stations were maintained during the fiscal year 1902 at Sitka, Kenai, and Rampart. The experimental work has included the growing of cereals and vegetables, methods of reclamation, drainage, and fertilization of land, and the curing and ensiling of forage crops. In all these lines successful results were obtained, and much information which will be of use to persons attempting agriculture in Alaska was acquired. The survey of different portions of Alaska with reference to their agricultural possibilities was continued. The special agent in charge made a journey through a large portion of the Yukon River Valley. A reconnoissance of the Copper River regions and portions of the Fortymile country and the Tanana River Valley was made during September, 1901, by the assistant who had been in charge of the station work at Rampart. He estimated that in the region covered by his journey there was some 2,000,000 acres of land suitable for farming and pasture. Grass grew abundantly and luxuriantly in large regions.

The distribution of seed of hardy varieties of vegetables, cereals, and grasses has been continued and extended, seed for use the present season having been sent to some 750 addresses. Many reports of trials of seed previously sent have been received, and in this way much useful information has been secured. It is evident that the efforts made by the Department to aid the residents of Alaska in their agricultural work by distributing improved varieties of seeds have produced beneficial results. Not only has this been of advantage to the white population, but the natives also are learning to cultivate gardens, and it is reliably reported that there is a large increase in the number of natives who attempt to cultivate small patches of ground.

The equipment of the stations in Alaska has been increased by the erection of a barn, cottage, and small blacksmith shop at Sitka and the completion of a small station building at Kenai. During the present year a beginning will be made of establishing a nursery of hardy fruits at Sitka. Only a limited amount of work in this line can be done until a horticulturist is added to the station staff. It is also planned to secure a small flock of Angora goats, with a view to ascertaining whether these animals can be successfully reared in the coast region of southern Alaska. The plants naturally growing in this

region will furnish abundant forage for goats. The work at Kenai will be continued and similar operations will be carried on at Rampart and Wood Island and in the Copper River region.

It is hoped to complete the headquarters building at Sitka during the present year. The cost of this work will be about $2,000. As soon as possible a small herd of cattle should be placed at the Kenai station and experimental work in animal husbandry begun. This would involve the building of a barn there and the employment of additional laborers. The station at Sitka should have an equipment of chemical apparatus sufficient for simple chemical work.

As long as the income of the stations is on the present basis it will not be possible to do more than maintain the stations at Sitka and Kenai and do a very limited amount of work at one or two places in the interior.

Hawaii Experiment Station.

A large amount of work has been done at the Hawaii experiment station during the past year in clearing and preparing for cultivation portions of the tract reserved for the station and establishing plantations of fruit and other valuable trees and experimental plats. The buildings begun the previous year were completed, and the station now possesses a residence for the special agent in charge, an office and laboratory, stable, cottages for laborers, water tanks, etc.

Experiments have been begun with potatoes and taro to overcome the very destructive diseases which seem to threaten the extinction of these crops. Taro forms the principal food of the Hawaiians, and the ravages of the blight have so curtailed the supply that there has been actual suffering in some places because of the shortage. At present the experiments are being confined to the lowland taro, and an effort is being made to find some remedy for the disease that attacks the root. Dry-land taro does not appear to be as susceptible to disease, but it will be studied also. It was found in many cases that immature and diseased cuttings were used for planting. The lowland form of taro requires extensive irrigation, and in practice the land is kept flooded for a considerable time. Wherever the water was allowed to become stagnant it was found that the root rot was most prevalent. By the use of fertilizers it was found possible to actively stimulate the growth of the plant and make it less liable to disease. Wherever a liberal application of lime was made there was no disease, and with care in the management of the water, selection of cuttings, rotation of crops, and use of lime and fertilizers it was found possible to not only reduce the disease, but to considerably increase the production of the crop.

The experiments with potatoes were conducted upon the island of Maui in cooperation with one of the residents of that island. This island formerly produced the most of the potatoes grown in the archi-

pelago. A disease locally known as black rot has for ten or more years been seriously depreciating the crop. This, as has been determined by the station authorities, is due to a soil fungus, and experiments are being undertaken to combat it. In the field investigations 45 varieties of potatoes were grown under similar conditions, and marked differences were noted in the susceptibility of the varieties to disease. This work is to be followed up in the hope that some sorts may be found which are nearly or quite resistant to disease.

Investigations were begun on the diseases of poultry, and a bulletin was issued in which suggestions were given for the care of fowls and treatment of the diseases to which they are especially subject, and as a result of which poultry and eggs are excessively expensive in the Hawaiian markets.

Attention has also been given to fiber plants, mangoes, the castor bean, pineapples, peppers, and rubber and cork oak trees, and other plants believed worthy of investigation and development. A study has also been made regarding the use of pumps for irrigation purposes in the Hawaiian Islands, where the pumping of water for this purpose has in all probability reached its highest development. Members of the station staff have visited other islands of the group and an attempt has been made to get into touch with all the agricultural communities. Farmers' institutes are being organized under the auspices of the station. Bulletins on chickens and their diseases and on taro have been prepared and others are in course of preparation. It is clear that there is a wide field for agricultural investigations in this Territory. Owing to local conditions of soil, temperature, rainfall, and other natural conditions, the station will be obliged to do much work in different localities.

The presence of enormous numbers of destructive insects is one of the chief obstacles to agriculture in Hawaii. The land areas are small and the uniformity of seasonal temperatures presents no check to the development of insects which may have been introduced from continental regions. As a result the insects speedily lose their distinctive habits. Many of the introduced species no longer have a definite life period, but breed at all seasons and are practically in continuous existence throughout the year, swarm following swarm, with no intervening period when the land is free from their ravages.

There are a number of serious fungous diseases of plants which require investigation, both because of the local losses caused by them and on account of the possibility of their being carried to other parts of the islands. The work on the taro rot and the Fusarium disease of the potato will need to be continued for several years.

There are many problems of both scientific and practical interest which require the services of a chemist. Soil and water analyses, the study of the rôle of mineral nutrients in plants and soils, the composi-

tion of Hawaiian foods and feeding material all should be given attention. Investigations should be made as the occasion requires of other agricultural products which may lead to the establishment of local industries, such as fiber plants, tans, dyestuffs, rubber, vanilla, coffee, tobacco, silk, fruits, and vegetables.

Considering the numerous agricultural problems requiring investigation in the Territory of Hawaii, the experiment station there should have added to the station force a chemist; the apparatus and other equipment should also be increased, and provision made for the printing and distribution of station publications.

Porto Rico Experiment Station.

The agricultural experiment station in Porto Rico is now established on a permanent basis. This result has been secured through the cooperation of the insular government and legislature. A bill appropriating $15,000 for the purchase of a suitable tract of land for the station was passed in February, 1902. Under this law bids were called for which were closed the 12th of May. The result of these negotiations was the purchase of approximately 230 acres of land adjacent to the city of Mayaguez. The land is varied in character and well located with reference to the city. It gives promise of making a very desirable site on which to carry out the objects of the experiment station.

On this tract it is proposed to begin field tests of leguminous crops, grasses, corn, rice, beans, and vegetables. A nursery and orchard of tropical fruits, including those grown on the island, and promising varieties from other countries will be established for experimental purposes. With the temporary experiments undertaken last year much useful information has been obtained regarding soil and climatic conditions as related to the growth of crops in the island. An important study has also been made of the Changa, a mole cricket, which is the most injurious insect of the island, and a bulletin regarding this insect will soon be published in both Spanish and English for distribution in Porto Rico. Experiments looking toward the improvement of coffee, now grown so largely in the island, have already been well begun, and it is proposed to extend them materially during the coming year.

It is important that the Porto Rico station should undertake experiments with live stock, but it will not be possible to do much in this direction unless the resources of the station are increased. Additional funds will be required for the employment of a competent live-stock expert, the purchase of animals, and the general expenses of feeding experiments. In order to effectively conduct experiments with fruits a horticulturist should be added to the station staff.

Now that the Porto Rico station is permanently located, it should, in my judgment, receive the same financial support from the National Treasury as is given to the stations organized under the act of Con-

gress of March 2, 1887. Considering the large population to be maintained by agriculture in Porto Rico, every effort should be made to develop the agricultural resources of the island. The station will be called upon to aid in the solution of a great variety of problems. The range and effectiveness of its work will necessarily be limited by the funds at its command. When the nation does as much for the Porto Rico station as for stations in the other States and Territories, there will still be need for additional financial assistance from the insular government. The cordial support which has been given the station by the Government and the substantial grant of money voted by the insular legislature for the purchase of land for the station have given evidence that the people and government of Porto Rico appreciate the importance of this enterprise and are willing to supplement the efforts of the National Government in this direction. As the work of the station develops, additional buildings and equipment will be needed, and it is confidently expected that these requirements will be met by the local legislature.

Nutrition Investigations.

The nutrition investigations have been continued along the same lines as heretofore, including dietary studies, and digestion, cooking, and metabolism experiments. These studies have been carried on in cooperation with universities and experiment stations in Maine, Massachusetts, Connecticut, New York, Tennessee, Illinois, California, Minnesota, Vermont, and Georgia. The respiration calorimeter used in these investigations has been improved, and the studies during the past year with this apparatus have had reference especially to the relative efficiency of fats and carbohydrates as sources of energy for the performance of muscular work. To further study the relation of diet to muscular work, dietary studies with lumbermen performing severe work in the forests of Maine have been made. Among other subjects of investigation have been the digestibility and nutritive value of bread made from different kinds of flour; the effect of cooking on the nutritive value and digestibility of different kinds and cuts of meat; the relative nutritive value of different kinds and combinations of fruits and nuts, and the comparative metabolism of nitrogen, sulphur, and phosphorus. Five bulletins regarding the results of nutrition investigations were published during the past year. Special efforts have been continued to bring the results of this work to the attention of schools and colleges, physicians, scientists, superintendents of public institutions, persons engaged in philanthropic enterprises, etc.

At the summer school of nutrition and bacteriology, held at Wesleyan University, Middletown, Conn., in July, 1902, under the direction of the special agent in charge of nutrition investigations in connection with his work as professor in that institution, the methods and

results of the nutrition investigations of this Department were explained to a considerable number of teachers of domestic science from different regions, and others who have engaged to a greater or less extent in the teaching of nutrition, bacteriology, and kindred subjects in the agricultural colleges and other institutions.

As stated in my previous report, it is very desirable to extend the nutrition investigations through a systematic study of dietaries in public institutions. Plans for beginning this work have already been made and considerable material, including summaries of results of early investigations, has been collected. Through an arrangement with Dr. A. B. Richardson, superintendent of the Government Hospital for the Insane in the District of Columbia, dietary studies will be made in that institution during the current year in accordance with plans furnished by this Office.

In early times the idea was prevalent that the diet of prisoners and other delinquent classes should be so poor and inadequate that it constituted a punitive measure. This is now recognized as wrong, and most civilized nations endeavor to feed such persons adequately. The food requirements obviously vary with the amount of work performed, and in most cases it is essential that the cost of the food be moderate. Food investigations are required in prisons and other institutions in order that satisfactory dietary standards may be formulated, and also to compare the rations actually fed with proposed standards. The importance of such studies has been often recognized in the past; for instance, under the authority of the institutions' commissioner in Boston, Mass., dietary investigations were carried on in a number of reformatories, etc., in that city. Studies have also been made at the reformatory at Elmira, N. Y., some of which had the special object of determining whether it was possible to favorably affect the moral welfare of inmates through their diet.

Under special government authority the diet in Scotch prisons has been recently studied, and mention may also be made of recent work of a similar nature in Berlin. In many cases it has been found that it is possible to furnish a more satisfactory diet and at the same time diminish the cost.

Nutrition investigations have also been made in almshouses, orphan asylums, and similar charitable institutions in times past in this and other countries—Germany having taken the lead. The importance of providing a proper diet for inmates of such institutions has received government recognition in Great Britain, and investigations bearing on the subject have been undertaken there. An adequate diet should unquestionably be supplied to all who are dependent on charity of this sort. The numerous studies which have been made show that with proper care good food may be provided at a reasonable cost. While the diet in many institutions is undoubtedly satisfactory as regards

kind and cost, it is not too much to say that in very many others dietary studies would show the possibility of diminishing the cost and at the same time improving the quality. The benefit to the inmates and saving of public money in this way seem worthy of all possible effort.

In previous reports I have called attention to the fact that investigations were needed to determine the food habits and requirements of residents of tropical countries. This matter is becoming of increasing importance, owing to the continuance of soldiers, sailors, and civil officers of the United States in such regions. This, and the fact that large numbers of our people are called to tropical regions by our rapidly extending commerce, would seem to justify the institution of such investigations to determine the most suitable diet under the new climatic conditions. It is well known that a suitable diet is a matter which has a great effect upon the maintenance of good health of old residents in tropical countries, and is even more important for recent arrivals. The U. S. Army has devoted considerable attention to this subject, as have also German, British, and other European investigators, generally under the auspices of the army or navy of their respective Governments. The lack of agreement regarding the diet best suited to residents of the Tropics shows that more extended investigations are required.

The economic feeding of troops and other residents in tropical regions obviously depends in some measure upon the utilization of local food products. Many of these products are comparatively unknown outside the Tropics, and their food value has never been studied.

Irrigation Investigations.

Two causes have operated during the past year to increase the interest in the Department's work for irrigated agriculture. One was the desire of the arid States for the creation of conditions which will result in the largest and best use of the water supply, and the other the drought which prevailed throughout the Middle West in 1901 and in the South during 1901 and the present year. As a result of this interest, requests for information and advice have been far more numerous than ever before, and it is only through the increased appropriation made by the last Congress and the better organization of the work that these demands have been met.

The distribution and use of Western rivers require that the irrigation industry shall be organized, and in order to provide for this it is necessary that there be a better understanding of the subject than now exists. The first need is for the facts. We need to know how much water is being used, where it is being used, how much water is required for the maturing of crops, how it can be distributed with the least loss, and how applied to the best advantage. This information

the Department is securing and disseminating through this investigation, and in doing this it has enlisted in its service many of the leading irrigation engineers and scientists of the arid States. The services of these men would have involved a prohibitory expense if it had been necessary to employ them continuously, but through cooperative arrangements with the State agricultural colleges and experiment stations and the State engineers' offices the scope of both local and national investigations has been broadened and made more effective, while the outlay to each of the parties to these arrangements has been greatly reduced.

THE DISTRIBUTION AND USE OF WATER.

The Department is now making measurements of the water used in irrigation in all of the arid States but one and in a number of humid States. The results of these studies during the past three years, while not conclusive, have already done much to educate farmers and ditch managers as to the direction from which improvements of methods and practices must come. They have made plain the need of better work in constructing and maintaining canals. They have shown that the water lost through leakage in transit is far greater than has been generally supposed, and that its loss causes a double injury. It returns in many instances to the surface of lower-lying fields and converts productive areas into unsightly swamps and marshes, rendering them for the time practically worthless. The loss of water through evaporation from these submerged areas is large. If this could be prevented and the water saved applied to crops it would largely increase the cultivated area. One of the leading lines of work of these investigations will therefore be a more careful study of losses from seepage, in order to determine measures by which this can be lessened.

In a number of instances these studies have led to careful inquiries by canal owners to determine whether or not it will be profitable to cement the main ditches and canals, and to requests for further assistance from this investigation to determine how this may be done to the best advantage. The Report of Irrigation Investigations for 1901 will give the methods pursued and the cost of cementing one of the principal canals of southern California.

DRAINAGE SURVEYS.

In response to numerously signed petitions from the agricultural and horticultural interests of the valley of Kings River, in California, the Department has carried on a comprehensive drainage survey to determine what plans can be best adopted for relief of the overwatered lands of that section. This work has been under the direction of Prof. O. V. P. Stout, of the University of Nebraska, and the report, which is now approaching completion, will give the plans and estimates for

two methods of removing the surplus water and making it available for use elsewhere. The carrying out of these plans will probably require additional legislation on the part of the State, and a local committee has been formed to frame bills and promote the enactment of needed laws.

At the request of the Hon. A. J. McCune, State engineer of Colorado, the Department has assisted in the investigation of the drainage problems of that State. This work is under the direction of C. G. Elliott, a drainage engineer of wide experience. The information already gained makes it certain that these studies are to be worth many times their cost, both to the localities where they have been carried on and in their influence on the larger and better use of the water supply. Some fears have been expressed that the water coming from these drains would be unfit for use because of the large percentage of alkali it contained, but analyses made by the State experiment stations of Colorado and California have shown that this is not the case.

STUDIES OF IRRIGATION LAWS.

The larger problems which the complete use of Western rivers is destined to create and the measure of public control which recent irrigation legislation renders inevitable gives added interest to the Department's studies of the legal and economic phases of irrigation. The division of the water of streams among farms scattered for hundreds of miles along their courses, so that each acre cultivated shall receive its just share of the common water supply, is one of the most complex administrative problems which confronts Western agriculture, and the establishment of titles to these streams by methods which shall prevent speculative appropriations of water and the creation of water monopolies is one of the imperative needs of the immediate future.

The larger opportunities which national aid affords should awaken the civic pride of the States benefited in seeing to it that not only in material development but in their institutions the irrigation systems of this country rank among the foremost of the world.

A beginning of the studies of the conditions and experiences of other lands was made during the past year. Mr. C. T. Johnston, assistant chief of these investigations, visited Egypt for this purpose. Through the courtesy of Government officials he was enabled to become fully acquainted with the administration of the laws which govern the use of the Nile, and his report will show the character of the rights to water recognized and the manner in which these rights are enforced in times of scarcity. While differences in conditions will doubtless prevent the adoption of many of the methods pursued, the lesson of one of the oldest irrigated countries in the world can not fail to be of great interest and value to one of the youngest. In addition, Mr.

Johnston's report will present many matters of practical information regarding the size and construction of canals, the manner in which water is distributed and applied to crops, and the yield and value of the products.

A number of the arid States are cooperating with the Department in these studies of sociological and legal problems. Montana and Nevada appropriated money for such studies, and the irrigation officials of Wyoming, Colorado, and Idaho have given both personal and official aid. No branch of the Department's irrigation work has received more cordial recognition than its studies of legal and sociological questions, and it is believed that they are destined to exert a beneficent influence on the future industrial life of the West.

IRRIGATION IN THE HUMID STATES.

The development of the rice industry in Louisiana and Texas has had the effect of enormously increasing the value of land hitherto used only for grazing purposes or not at all. Its success has led to the investment of large sums of money and a marked increase in the population. In the amount of money invested in canals and pumping plants and in the increase in the acreage reclaimed, the rice districts of Louisiana and Texas have made as great progress during the past two or three years as any of the irrigated districts of the West. This rapid growth has given rise to a number of practical problems in which the aid of the Department has been invoked.

Establishing and maintaining pumping plants requires a knowledge of the amount of water required, the cost of furnishing it, and the methods by which waste in use may be reduced to the minimum. The light rainfall of the past two seasons has also made it manifest that the time is not far distant when there will be need for establishing rights to the use of streams and some division of their water supply among these irrigators. During the present season the rainfall from June to September was little more than that of many of the arid States, and this, combined with the large increase in the irrigated acreage, has made the drain on some streams cause their current to be reversed and salt water to flow in from the Gulf.

The growth of irrigation in the Southern States is not, however, confined to the rice districts. During the past year the experts of this investigation have furnished information and advice to farmers in Georgia, Alabama, and the Carolinas under which a number of irrigation systems have been installed. The drought of the present season has made the first year's trial a marked success, but it will require a number of years to determine to what extent irrigation can be profitably employed in this section. The fact that the Department was able to answer these inquiries has saved large sums of money to individual farmers. In nearly every instance they had planned to put in pumps

of too small capacity to have been of any real service, and the attempts would have resulted in disappointment and loss and probably have delayed adoption of what promises to be an important aid to both agriculture and horticulture.

The cooperative irrigation studies undertaken in connection with the State experiment stations of Wisconsin, Missouri, and New Jersey have been continued, the object being to determine how far and by what method irrigation can be profitably employed in the humid States.

In view of the increased interest in the questions with which the irrigation investigations of this Department deal, growing out of the rapid development of our irrigation system under private as well as public auspices, there is constantly enlarging demand for the services of our irrigation experts and for the published results of their investigations.

Agricultural Engineering.

In order to answer the inquiries received by the Department and to make the irrigation investigations of the greatest practical benefit, it has been necessary to include studies of the applications of power whose relation to irrigation is made apparent only by a thorough understanding of existing conditions. Farmers under irrigation apply to the Department for information regarding the use of streams and canals for power purposes. Many who desire to irrigate small tracts apply to the Department for information as to whether or not pumping will pay, the kind of pumps to be used, and the amount of water required. Inquiries are received as to the relative economy of different forms of power, and whether coal, oil, gas, electricity, or wind power will best serve the irrigator's purposes. These questions should be answered because nothing is more wasteful than to have each man learn experimentally for himself what has been found out elsewhere, but the attempt to do this has made agricultural engineering an important feature of these investigations, and raises the question whether the usefulness of the work of this Department can not be materially augmented by entering upon a systematic study of agricultural engineering as related to the interests of all our farmers.

The possibilities of this subject can be illustrated by the one item of farm machinery. In the past twenty years the capital invested in the manufacture of agricultural implements has increased from sixty to one hundred and fifty-seven millions, and the value of the product has more than doubled, but more significant than this increase in its importance have been the changes in its character. Leaving out of consideration the larger and more important classes of farm machinery, such as reapers, mowers, and thrashers, which are usually thought of as supporting the claim that American inventive genius and mechanical skill have surpassed the world in constructing farm machinery, and taking

up machines and implements but little thought of in this connection, it will be seen that the changes wrought in the past twenty years have been little less than revolutionary, and have been an important factor in maintaining our commercial supremacy. The invention of the disk harrow to supplement the types formerly used, the invention of the disk plow to compete with the types in use for centuries, the still more recent invention of corn-harvesting machinery, all serve to show the rapidity and radical character of the evolution which is now going on.

These facts, in connection with the increasing demand for efficient labor-saving devices resulting from the growing scarcity of farm labor and the organization and development in foreign countries of institutions for the systematic study and improvement of farm machinery, renders it important that we should not longer neglect this field of inquiry. There is an excellent opportunity for the Department to do an important service in promoting the continuance of our agricultural supremacy through the use of farm machinery by investigations regarding the fundamental principles on which the further improvement of such machinery must depend.

At present the Department is not in a position to answer the numerous requests for information on these subjects, and these demands will undoubtedly increase with the growing application of new forms of power to farm work and the development of new kinds of labor-saving machinery. The agricultural colleges and experiment stations throughout the country are beginning to realize the need of such studies, but they find great difficulty in establishing the work on an efficient basis owing to the lack of definite information in available form. It is believed that this Department should undertake to collate and publish such information, as well as to institute investigations which will keep the farmers and manufacturers of the country informed of the progress being made and show them the lines in which it may be extended.

Investigations in agricultural engineering should also include problems relating to the laying out of farms, such as the arrangement of buildings, drains, water supply, and disposal of sewage. The character of the agriculture of the twentieth century has made farm buildings as complex in design and varied in use as factories, and there is a wide field of study for improvement in design and for determination of the best material to be used in their construction.

The breeders of high-bred and valuable live stock need to give almost as much attention to stable sanitation as is given to house sanitation, but the data on which to plan efficient systems of ventilation are of the most limited character. It is believed that careful studies of the designing of farm buildings will be a benefit to agriculture, not only in saving large sums of money in the selection and combination of material used, but in the adoption of more convenient and effective plans.

Need of Adequate Funds.

This review of the work of the Office of Experiment Stations in all its phases shows very conclusively the necessity for more liberal appropriations, as submitted in my estimates for the ensuing year, for carrying on the several lines of work assigned to the Office of Experiment Stations. It is particularly desirable that the stations in Alaska, in Hawaii, and in Porto Rico, which are under the direct supervision of the Secretary of Agriculture, should be as liberally dealt with in this respect as are the stations in the several States and Territories of the Union.

DIVISION OF FOREIGN MARKETS.

Investigations made by the Division of Foreign Markets regarding the status of our agricultural export trade in the principal markets of the world disclose an exceptional activity on the part of some of our most formidable competitors for that trade, and particularly such countries as Australia, Canada, and Argentina. These progressive exporting countries have within the last few years been taking exceedingly active measures for the extension of their foreign business. As was pointed out in a publication recently issued by the Division on the subject of the British agricultural import trade, about two-thirds of the farm produce required by the British people to supplement their domestic supply is now being purchased from the various competitors of the United States. The success of these competing countries suggests the importance of constant watchfulness in the interests of our own export business.

Agricultural Exports in 1902.

Statistics recently prepared by this Division show that the agricultural exports of the United States for the fiscal year 1902 had a value of about $860,000,000. In comparison with the record-breaking figures of the preceding year, the value for 1902 exhibits a rather marked decline. Next to the exceptional record for 1901, however, it is the largest ever reported, being decidedly above the average of the decade.

The decline from the high mark reached by our agricultural exports in 1901 was principally due to the fact that a serious shortage in the corn crop left a comparatively small supply of this important export grain available for shipment to foreign markets. Our exports of corn during 1902 amounted in value to only $16,000,000, while in 1901 we sent abroad consignments worth nearly $83,000,000. The loss to our trade through the diminished shipments of this product alone exceeded $66,000,000.

Aside from the extraordinary falling off in corn exportation, the

most noticeable instance of decline occurred in the shipment of cotton. Our cotton exports for 1902 had a value of $292,000,000, or about $23,000,000 less than the figures recorded in 1901, when there were shipments worth $315,000,000.

Trade in Forestry Products.

The more active interest recently aroused in the question of forestry in the United States has created a larger demand for statistical information regarding our commerce in forestry products. To meet this demand the office devoted considerable time during the year to the preparation of statistics on the subject.

Last year the United States exported nearly $50,000,000 worth of forest products. Lumber in its various forms, not including heavy timber, comprised the principal item, the shipments under this head having a value of about $26,000,000. The exports of heavy timber, sawed, hewn, or in logs, were valued at about $10,000,000. Wood pulp and the minor products of the forest together formed an item of about $13,000,000.

Europe furnishes the principal foreign markets for American lumber. The United Kingdom is decidedly the largest purchaser, but extensive sales are also made each year to France and to Germany. Markets for our lumber, however, are found in nearly every quarter of the world. The neighboring countries of Canada and Mexico make considerable purchases. A promising market is now being developed on the island of Cuba, where in 1902 consignments worth over $1,000,000 were received. During the last few years a considerable export business in lumber has been established with the Philippine Islands. In 1902 shipments valued at $246,000 found a sale there. These islands, although rich in tropical hard woods, promise to afford an extensive market for the building lumber supplied so abundantly by the great timber districts of our Pacific slope region. Additional markets for that region will undoubtedly also be developed in other parts of the Orient.

Notwithstanding the immense timber areas of the United States, a larger sum is annually expended in the importation of forest products than is received in payment for such products exported. This is because of our extensive requirements as regards certain articles yielded only by the forests of the Tropics. It is quite probable that before many years the island possessions of the United States, and particularly the Philippine Islands, will supply a large part of the tropical forest products we are now obliged to import from foreign sources.

Trade with Island Possessions.

In view of the lively interest that is taken in the course of trade between the United States and the several island possessions, the office

recently prepared some statistics to show the status, so far as products of agriculture are concerned, of our commerce during the past fiscal year with Hawaii, Porto Rico, and the Philippines. From the statistics in question it appeared that, while our agricultural trade with Hawaii suffered a rather marked decline in 1902, there was a considerable increase in the amount of such business carried on with Porto Rico and with the Philippine Islands.

OFFICE OF PUBLIC ROAD INQUIRIES.

The work of this office has been prosecuted along the same general lines as heretofore, but its practical features have been enlarged. Object lesson and experimental road work have received more attention than ever before, and efforts along this line appear to be doing much to stimulate the building of better highways in many sections. Practical work in the testing of road materials has also been continued and enlarged. The field work of the Director, his assistant, and several road experts and special agents who attend and address conventions, consult with and advise road officials, and come in personal contact with the people of many communities, is another important feature of the practical work of the office which is producing excellent results.

Cooperation in Object Lesson Road Work.

The building of object-lesson and experimental roads has during the past year assumed a position of higher importance than ever before in the work of the office. Most of this work during the past year has been done in cooperation with several forces, each having a special interest in the improvement of the public highways. The first of these cooperating forces, the National Good Roads Association, was organized by public-spirited citizens to promote, by agitation and organization, the improvement of the public roads. Its work is educational in character, and one of its aims is to organize State and district associations. The second of these forces, the manufacturers of road-building machinery, contributes to the cooperative work the use of machines for building sample roads as well as experts to operate and explain this machinery. The third, one or another of the great railroad corporations, contributes the use of a train, popularly known as a "good-roads train," to carry from place to place along its lines the machinery and the representatives of all the cooperating forces. In this work the railroad corporations are actuated by a desire to develop the country tributary to their lines, particularly to secure the improvement of the roads over which commodities must be hauled to and from their stations. The Office of Public Road Inquiries of the Department constitutes the fourth cooperator. Its work is advisory, supervisory, and educational. The people of the various communities

in which conventions are held and sample roads built may be mentioned as a fifth cooperating force, and a very important one, since it is not only the principal recipient of the benefits, but must furnish the money, the materials, the common labor, and the horsepower needed in building the object-lesson roads.

The character of this cooperative work can best be indicated by briefly describing the work done in the South during the past autumn, winter, and spring. In October, 1901, the Southern Railway Company fitted up a good-roads train, consisting of a locomotive and 12 cars, which carried the representatives of all the cooperating forces and the road-building machinery furnished by five of the principal concerns that manufacture such machinery in the United States. The itinerary of this train extended through six States—Virginia, North and South Carolina, Tennessee, Alabama, and Georgia—and covered a distance of 4,037 miles, the whole campaign occupying over five months. Stops of a week or more were made at eighteen different places, at each of which a road convention was held and object-lesson and experimental road work was done.

This practical work included the improvement of earth roads, the building of gravel, chert, shell, sand-and-clay, and macadam roads, the object being to utilize local materials wherever possible and to illustrate the best methods of using them. Many thousands of people attended the sessions of these conventions and took lessons in practical road work. Addresses were delivered by many men of prominence in political, educational, and religious fields, as well as by scientific and practical road builders and representative farmers. Permanent good roads associations were organized in every State visited. It is believed that the work done has aroused a deep and permanent interest in road improvement in the States visited, and has started a movement for better roads that will ultimately yield results of inestimable value to the South. Plans for work of similar character in several Northwestern States have been matured and will be carried out during the current year.

Aside from the cooperative work just described, the Office has done much sample-road work in cooperation with State and county officials, educational institutions, and experiment stations. In this way sample roads have been built in four States: Maryland, West Virginia, Ohio, and North Carolina.

The demand for object-lesson road work of the character indicated is very great and comes from all sections. The Office has been able to comply with only a small part of the numerous requests for its active participation in the building of sample roads. During the coming year work of this kind will be extended as greatly as the force and means of the Office will justify. It should be remembered that this object-lesson work costs the Department nothing except the salaries and ex-

penses of its employees. In view of this fact and of its great practical value, the propriety of extending work of this kind seems apparent.

The road material laboratory is operated in collaboration with the Bureau of Chemistry, and its operations have already been discussed in connection with the work of that Bureau. The increasing demand for the services of this laboratory shows that its work is appreciated by practical road builders.

Special Agents.

The plan of dividing the whole country into four areas, known as the Eastern, Middle, Western, and Southern divisions, has been retained, but, owing to lack of funds, no special agents were appointed for the Eastern and Middle divisions. The special agents in the Western and Southern divisions have done a great deal of active field work, visiting different sections, attending and addressing conventions, collecting and disseminating information, and preparing and publishing matter on road subjects. It is expected that during the current year a special agent will be at work in each of the four divisions except the Eastern.

PUBLICATIONS.

Extent of Publication Work.

All the information acquired by this Department through its several bureaus and divisions by the means at its command finds its expression necessarily in the form of publications. The duty of issuing and distributing these publications is assigned to the Editor of the Department, under whose direction they are edited and prepared for the printer. The record of his work therefore accurately reflects the activity of the other Bureaus and Divisions of the Department. The statistics of publication work for the year, as reported by the Editor, show that in no previous year since the organization of the Department has this manifestation of activity in all the branches of the Department work been so apparent.

The total number of documents issued during the fiscal year was 757, of which 85 were publications of the Weather Bureau, and the total number of printed pages of new matter edited and prepared for the printer by the Division of Publications was 18,184. Counting pages of new matter, the increase in the matter edited during the year was 25 per cent over 1901 and 75 per cent over 1900. In spite of this unprecedented increase, there were in the hands of the Public Printer on June 30, 1902—the closing day of the fiscal year—112 miscellaneous publications, not including 47 Farmers' Bulletins.

Farmers' Bulletins.

Of Farmers' Bulletins, four-fifths of which are by law set aside for the use of Senators, Representatives, and Delegates, there were printed 6,150,000 copies, of which the Congressional distribution absorbed 4,289,126. While Senators, Representatives, and Delegates have failed to avail themselves of the full number of Farmers' Bulletins allotted to them, on the other hand, the number at the disposal of the Department has been inadequate.

Growth in the Publication Work.

The growth in the publication work of the Department during the past decade has been phenomenal. Every enlargement of the scope of the work of any one bureau or division, or the adoption by the Department of any new line of investigation or inquiry, inevitably brings about an increase in the work of publication. The development of the Department itself can therefore be accurately traced in the records of the Division of Publications.

Ten years ago the total appropriations for printing for this Department, including the salary roll of the Editor and his assistants, were less than $100,000. The total number of publications was 210, and the aggregate number of copies issued was 2,689,084. Last year the total appropriations for the same purposes exceeded $380,000; the number of publications issued was 757, and the aggregate number of copies 10,586,580. This increase, amounting to nearly 300 per cent in appropriations and number of copies issued and to over 250 per cent in the number of publications, obviously supplies an accurate measure of the growth and development of the Department itself.

Cost of the Department Printing.

The amount appropriated for printing for the use of this Department is, however, far from being the total amount expended for the publication work of the Department. The Yearbook and several other reports issued annually are paid for by special appropriations, and no session of Congress passes without special provision being made for the publication of several important reports for which the regular printing appropriation is inadequate. The cost of the publication work of the Department thus does not fall short of $800,000 a year, to say nothing of the fact that this enormous mass of published matter is carried free through the mails to all parts of this country, to Canada, and to Mexico, at an expense to the Government which can not be less than $200,000 yearly at the least.

The diffusion of the information acquired by the Department, therefore, represents an annual expenditure of about $1,000,000, a comparatively small per cent of the amount required to defray the total

expenses of the Department, but one, nevertheless, without which all the other expenses would be useless. A serious problem is presented by the fact that as the Department grows and becomes better known and its work more valuable and more highly appreciated, the demand for its publications increases even more rapidly than the supply, and with a constituency of over 10,000,000 workers on the 5,750,000 farms of the United States, of which probably not more than one-tenth are reached at present in anything like adequate measure by the publications of the Department, it is obvious that the demand upon us for published matter is bound to assume larger proportions, and, under the present system, to involve greater expense.

THE LIBRARY.

The work of the Department depends in a large measure upon an available collection of books relative to practical agriculture and to scientific experimentation at home and abroad. With this end in view the library has been increased from year to year until it now contains 75,000 volumes and pamphlets pertaining to the special lines of work carried on in the Department. As a working scientific library it is among the first, and as such is frequently made use of by scientists in distant parts of the country.

Accessions.

Each year some especially rare scientific works and many valuable sets of periodicals are added to the library, which are not available elsewhere in the country. With a larger appropriation more such works, in addition to current publications, could be procured to the great advantage of the public service.

The files of agricultural papers are particularly noteworthy, including representative publications from all parts of the world. This is one of the special collections most frequently consulted, and, in addition to its current value, it is a most important one as a source from which the progress of agriculture may be traced in future years. With few exceptions these publications are gifts from the publishers. Many gifts from scientific writers in the form of monographs and of reprints are also received, adding largely to the number and to the value of the annual accessions.

The most important source of accessions next to that by purchase is by exchange. The numerous publications of the Department are widely distributed to societies, universities, and other institutions of learning. In return for these, thousands of separate numbers of serial publications are received. The Library is the depository for all exchanges, that they may be systematically arranged and carefully preserved for the present and future benefit of the Department.

TECHNICAL WORK.

The card catalogue is kept up to date. The last appropriation provided for an additional cataloguer to further this branch of the work. In addition to the card catalogue, a volume entitled "Catalogue of the Works relating to Botany in the Department Library" has been published. It is expected that two such catalogues of books on special subjects in the Library will be issued each year until a complete subject catalogue is thus printed.

The accessions bulletins have been published quarterly, as heretofore. Two additional bulletins, containing works relating to botany and to irrigation, respectively, have also been printed. The card index to the publications of the Department has been continued. The number of sets of the cards has been increased to meet the demands for the index from depository libraries.

Serial publications constitute so large a part of the accessions to the Library that it is necessary to devote much time and money to binding, both for the preservation of the volumes and for convenience in their use. The past year 1,300 volumes have been bound, and although this is the largest number recorded for any one year, it could well be doubled with advantage to the Library if funds permitted.

ESTIMATES AND APPROPRIATIONS.

The estimates for the fiscal year ending June 30, 1903, which were prepared in the Division of Accounts and Disbursements, were submitted to Congress through the Secretary of the Treasury with an explanation of all changes from the appropriation of the preceding year. These estimates amounted to $4,789,540, or $872,120 more than the appropriation for 1902. The amount finally appropriated for 1903 was $4,503,960. These amounts are exclusive of the $720,000 appropriated for the agricultural experiment stations, and the general printing expenses.

The statutory rolls of the Department increased from $533,640 in 1902 to $630,760 in 1903. This does not represent an actual increase either of salaries or clerical force, but was the result of the transfer to the statutory rolls, on the recommendation of the Agricultural Committees of both the Senate and House of Representatives, of clerks who have heretofore been paid from the lump-sum rolls of the Department.

During 1902 $12,600 was paid for the rent of buildings in the District of Columbia, and the appropriation for the same purpose for 1903 is $21,700.

OFFICE OF THE APPOINTMENT CLERK.

The records of this office show that on July 1, 1902, the total number of employees in the United States Department of Agriculture was 3,789, of which 1,209 were executive officers and administrative assistants, clerks, messengers, and watchmen; 2,081 scientists and scientific assistants, and 499 laborers and charwomen.

During the fiscal year ended June 30, 1902, the appointments made on certificates of the United States Civil Service Commission numbered 305, including 10 reinstatements and 19 transfers from other Departments. Thirty-five persons declined appointment on civil-service certificates. There were 108 resignations, 22 removals, and 14 deaths.

EXPOSITION WORK.

The Department of Agriculture, in connection with other Departments of the Government, has, in compliance with the law, participated in various expositions in this and foreign countries; and it is now preparing an exhibit for the Louisiana Purchase Exposition which is expected to be the best ever made by the Department.

It is not intended to make this an exhibit of agricultural products and resources, differing in that respect from exhibits prepared for expositions in foreign countries, where an effort has always been made to exhibit the products and resources of the country in the hope of increasing our trade abroad. It is expected that the articles and material exhibited at St. Louis will illustrate as nearly as possible the workings of the various Bureaus and Divisions of the Department, giving to the people who may not have an opportunity to visit the Department a chance to see what it is doing to promote the agricultural interests of the country.

The preparation of the Department exhibit devolves upon the heads of the several bureaus and divisions, under the general direction of the Assistant Secretary, Hon. J. H. Brigham, the representative of the Department on the Government board, and who has served on several previous occasions in the like capacity.

Since the elevation of the Department of Agriculture to executive rank, the President has honored it by naming its representative as the chairman of the Government board at the various expositions.

MAGNITUDE OF AGRICULTURAL INDUSTRY.

In the industrial progress made by the United States during recent years there has been no more conspicuous feature than the growth of agriculture. It is doubtful if the magnitude attained by our farming interests is generally known. According to the reports of the Twelfth Census, the fixed capital of agriculture, comprising the value of the land, buildings, and improvements, of implements and machinery, and of live stock, amounted in 1900 to about 20 billions of dollars, or four times the fixed capital invested in manufactures. During that year

there were nearly 5,740,000 farms in the United States, covering an area of 841 million acres, of which 415 million acres consisted of improved land. These farms had a total value of $16,675,000,000, exclusive of farming implements and live stock. Farm implements and machinery formed an item of 761 million dollars, while the value of the live stock on farms exceeded 3 billions of dollars.

As further indicating the importance of agriculture in the United States, it is a striking fact that, according to the returns of the last census, about 40 million people, or more than half of our total population in 1900, resided on farms. Of the 29 million persons comprising the portion of our population engaged in gainful occupations, about 10 million, or more than a third, were returned as employed in agricultural pursuits. The people that work upon the farm outnumber by more than 3 million persons those who are occupied in the manufacturing and mechanical pursuits.

In 1899, according to the census returns, the produce of American agriculture, including farm animals and their products, had an aggregate value of nearly 5 billion dollars. Some of the crop values that make up this total were almost startling in their size. The crop of indian corn, which formed the leading item, had a value of 828 million dollars. The hay and forage of the census year were worth 484 millions. Wheat, which ranks next to corn among our cereal crops, gave a return of 370 millions, while oats were produced to the value of 217 millions. Cotton, the great crop of the Southern States, was valued at 324 millions.

In addition to these foremost crops, there were numerous others yielding returns in value that ran into the millions. Live stock and their products formed an exceedingly important factor in the grand total. The animals sold and slaughtered during the year were valued at above 900 millions. The several products of the dairy—milk, butter, and cheese—comprised an item of 472 millions, while poultry and eggs together brought a return of over 281 millions.

As a result of the intelligent application of improved methods to American agriculture, the produce of our farms has enabled us to increase the volume of our exports every year. Products of agriculture form about two-thirds of our entire export trade. Last year the exports from the farm amounted to 860 millions of dollars. The science of agriculture is in rudimentary stages in all lands. The education of producers from the field, so long neglected, has recently been undertaken in earnest in the United States. Our Government is doing more for the farmer than all other nations combined. Results are justifying expenditures, and the future will still further show the value of science applied to the farm.

Respectfully submitted. James Wilson, *Secretary.*

Washington, D. C., *November 29, 1902.*

CLIMATE OF THE FOREST-DENUDED PORTION OF THE UPPER LAKE REGION.

By Willis L. Moore,
Chief of Weather Bureau.

INTRODUCTION.

A comparatively small portion of the United States which has the necessary rainfall and the required thermal conditions for successful cultivation remains unoccupied; it therefore may be well at this time to compare the climatic conditions of the vast tracts of land in Michigan, Wisconsin, and Minnesota, which during recent years have been wholly or partly cleared of their commercial timber, with other regions in which cultivation of the soil is more general and profitable.

Successful agriculture depends upon the character of the soil, on the heat and the moisture of the growing season, and the manner in which the heat and the rainfall are distributed through the periods of germination, of growth, and of maturity.

The object of this paper is to show that the region under consideration possesses climatic conditions as favorable to the farmer as many regions in which he is more generally engaged.

The climate of any region depends upon its latitude, for its distance from the equator determines the intensity of solar radiation and the length of time that it is effective; upon the altitude of the region above sea level, since temperature[a] decreases in a definite ratio with elevation, the loss being about 1° for each 300 feet in free air, but considerably less where the land itself is elevated; upon proximity to mountain ranges, which not only increase the precipitation on their windward sides, but which, where the height is sufficient, partly or wholly deprive the region on the lee side of moisture; upon the nearness of considerable bodies of water and their position relative to the prevailing winds, as the great capacity of water for heat cools the contiguous region by absorption and evaporation in spring and summer and warms the same region by radiation in fall and winter; and finally, upon the frequency of cyclonic storms, which, by the gyratory inflow toward their centers, may draw the vapor-laden winds of the ocean as much as a thousand miles toward the interior of the continent.

The region under consideration is in north latitude 43° to 47° and west longitude 83° to 87°. The annual mean temperature ranges from about 46° in southern Michigan and Wisconsin to about 40° on the south shore of Lake Superior and less than 40° in northern Minnesota.

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[a] Temperatures in this paper are expressed in degrees Fahrenheit.

Other places in the United States having the same annual mean temperature are northern New England, North Dakota, portions of South Dakota, and Montana. The annual mean temperature of Nova Scotia is also about 40°, but its climate is not the same as that of the Upper Lake Region.

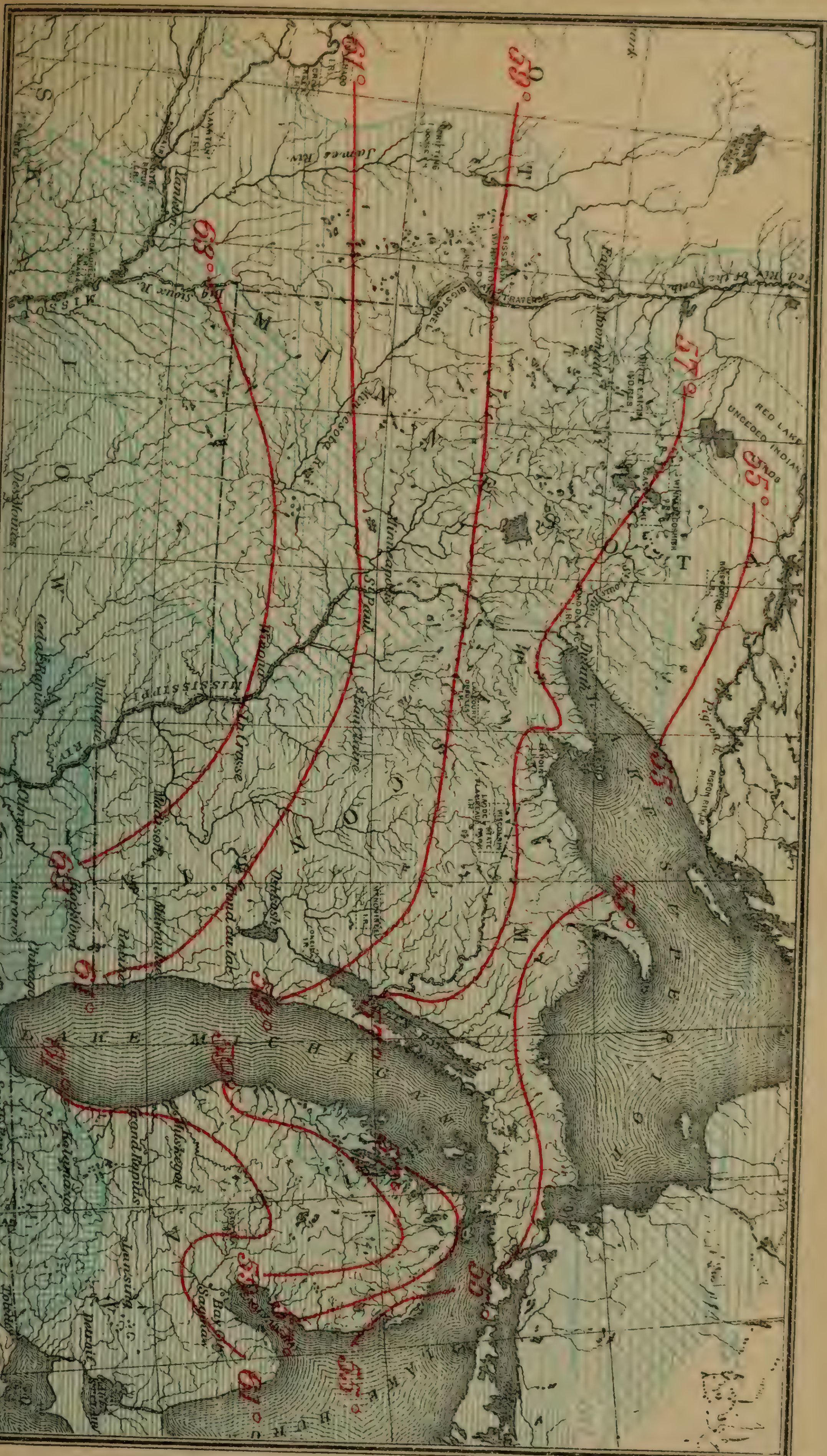
TEMPERATURE CONDITIONS OF THE UPPER LAKE REGION.

In comparing this region with Europe it is interesting to note that the line of 40° mean annual temperature enters the European Continent on the west coast of Norway in the latitude of the Arctic Circle. It bends sharply southeastward, passing across Sweden a little north of Stockholm, and thence southeasterly through Russia very near to the cities of St. Petersburg, Moscow, and Orenburg.

The mean annual temperature of a place in itself teaches but little of its agricultural possibilities. It may safely be assumed, however, other things being equal, that a plant or crop which flourishes under certain temperature conditions in one part of the world will do so in another under similar conditions of soil and moisture. It will be interesting, then, to compare the mean temperature of the crop season in the Upper Lake States with that of States immediately to the westward.

The mean temperature for the period April to September, both inclusive, for the Upper Lake States is shown graphically on Pl. I. It will be observed that the isotherms, or lines of equal temperature, in Wisconsin and Minnesota run almost due east and west after leaving Lake Michigan. This means that places in northern Wisconsin have practically the same mean temperature as places in Minnesota situated on the same parallel of latitude. In the case of northern Minnesota it appears to be slightly warmer than in the same latitude in the upper peninsula of Michigan. The mean temperature of the period April to September in the last named is 55°, the same as at St. Vincent, Minn., about 2° farther north. There are two reasons for this anomaly: First, the prevailing winds at St. Vincent are wholly from land surface, while those of the upper peninsula are partly from land surface and partly from water surface. The winds from Lake Superior are notably cooler in the summer season than they would be were the lake absent. The second reason why the temperature of the region of the Red River of the North, in which St. Vincent is situated, is warmer in summer than the upper peninsula of Michigan is because of its lower altitude. The effect of altitude as between Minnesota and the upper peninsula of Michigan is small, probably not more than 1°. It should be remembered, however, that when the difference in altitude is as much as 1,000 feet there will be an appreciable difference in the temperature.

The marked effect of Lake Michigan on the temperature of the growing season is shown by the sharp bend to the southward of lines



MEAN TEMPERATURE, APRIL TO SEPTEMBER, INCLUSIVE, AND MEAN ANNUAL PRECIPITATION, FOR THE UPPER LAKE REGI

57°, 59°, and 61° (Pl. I) where they approach the water on either side of the lake. This influence is beneficial to the horticulturist in holding back the early buds of spring, and the water gives great protection to fruit and vegetables against the early frosts of fall.

PERIODS OF KILLING FROSTS.

In selecting lands for agricultural purposes, it should be remembered that hillside slopes are less liable to frost than valleys, since the air as it cools by nocturnal radiation will flow down the hillsides and into the valleys by the force of gravity, while the air on the upper levels remains at a higher temperature. Lands that face the sun are also preferable to those with a northern exposure, since they receive more sunshine and the angle of incidence of the solar ray is much greater.

Killing frosts occur about the middle of September in northern Minnesota, northern Wisconsin, and in the interior of the northern portions of Michigan.

There is given in the following table the dates of first killing frost in the fall at a number of Weather Bureau stations during the last five years:

Dates of first killing frost in autumn, 1897–1901.

Station.	1897.	1898.	1899.	1900.	1901.
Bismarck, N. Dak	Sept. 16	Sept. 9	Sept. 19	Sept. 26	Sept. 18
Huron, S. Dak	Sept. 7	Sept. 10	Sept. 28	Sept. 17	Do.
Omaha, Nebr	Oct. 29	Oct. 6	Sept. 29	Oct. 17	Do.
Moorhead, Minn	Sept. 17	...do....	...do....	Oct. 16	Oct. 16
Duluth, Minn	Oct. 9	...do....	Sept. 28	Nov. 6	Do.
St. Paul, Minn	...do....	...do....	Sept. 29	Oct. 8	Oct. 13
Lake Winnibigoshish, Minn	Sept. 20	Sept. 10	....	Sept. 17	Sept. 20
Bayfield, Wis	...do....	Oct. 6	Sept. 29	Sept. 27	....
Butternut, Wis	Sept. 17	....	Sept. 14	Sept. 18	Oct. 3
Barron, Wis	Sept. 1	Sept. 9	Sept. 13	....	Sept. 18
Florence, Wis	Sept. 17	Sept. 10	...do....	Sept. 8	Oct. 4
Grantsburg, Wis	...do....	Sept. 9	Sept. 26	Sept. 27	Sept. 19
Medford, Wis	...do....	...do....	Sept. 13	Sept. 17	Oct. 3
La Crosse, Wis	Oct. 9	Oct. 6	Sept. 30	Nov. 7*	Oct. 4
Milwaukee, Wis	Nov. 6	Sept. 15	...do....	Nov. 5	Do.
Marquette, Mich	Oct. 29	Oct. 29	Sept. 23	Oct. 17	Do.
Lathrop, Mich	Sept. 27	Sept. 10	Sept. 14	...do....	Sept. 18
Escanaba, Mich	Oct. 29	Oct. 15	...do....	...do....	Oct. 3
Sault Ste. Marie, Mich	Sept. 27	Oct. 8	Sept. 22	...do....	Do.
Alpena, Mich	Sept. 21	Sept. 11	Sept. 23	...do....	Oct. 4
Cheboygan, Mich	Aug. 23	Sept. 10	Sept. 14	...do....	Sept. 19
Charlevoix, Mich	....	....	....	....	Oct. 15
Grayling, Mich	Oct. 3	Sept. 11	Sept. 14	Oct. 17	Oct. 3
Harrisville, Mich	....	....	....	....	Do.
Grand Haven, Mich	Nov. 12	Oct. 27	Sept. 14	Oct. 17	Oct. 20
Detroit, Mich	Nov. 3	Oct. 27	Sept. 30	Nov. 8	Oct. 18

Killing frosts in spring are probable in the latter part of May in the more northern districts, and in the first part of the month in the

southern districts. Occasionally a killing frost may occur as late as June, as, for example, on June 7 and 8, 1897, when frost was general throughout North Dakota, northern Wisconsin, and the interior portions of upper Michigan.

MEAN, MAXIMUM, AND MINIMUM TEMPERATURES.

Tables of monthly and annual mean temperature, absolute maximum, and absolute minimum temperatures follow. Reference has already been made to the mean annual temperature and the mean temperature of the crop-growing season.

Mean temperatures, in degrees Fahrenheit.

Station.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	No. years' record.
Bismarck, N. Dak	4	9	23	42	54	64	69	67	57	44	26	15	39
Huron, S. Dak	7	12	28	46	55	67	71	68	60	46	29	19	42
Omaha, Nebr	19	25	35	51	62	71	76	74	65	53	37	27	50
Moorhead, Minn	−1	4	20	41	53	65	68	65	56	43	24	12	37
St. Paul, Minn	11	16	27	45	57	67	71	69	60	47	30	19	43
Duluth, Minn	10	14	24	38	48	58	66	65	56	45	29	18	39
Lake Winnibigoshish, Minn	6	7	20	40	52	63	67	64	56	42	24	13	38
Bayfield, Wis	13	14	23	39	50	61	68	66	59	46	29	18	40
Butternut, Wis	11	12	22	41	52	63	67	63	56	43	27	16	39
Barron, Wis	8	10	23	43	53	66	68	65	57	45	26	18	40
Florence, Wis	13	13	22	41	51	62	66	64	57	43	28	18	40
Grantsburg, Wis	12	12	25	45	55	66	70	67	58	48	30	18	42
La Crosse, Wis	15	20	31	47	59	69	73	70	62	49	33	24	46
Milwaukee, Wis	19	23	30	43	53	63	69	68	61	49	35	26	45
Medford, Wis	12	13	24	43	54	65	69	67	59	46	28	12	41
Marquette, Mich	16	17	23	37	49	59	65	64	57	45	31	23	40
Escanaba, Mich	14	16	22	36	49	60	67	65	57	45	31	21	40
Lathrop, Mich	16	12	22	38	50	63	66	63	55	44	30	21	40
Sault Ste. Marie, Mich	14	12	22	38	48	60	62	61	55	43	30	23	39
Alpena, Mich	18	18	24	37	49	60	65	63	57	45	33	25	41
Cheboygan, Mich	18	15	24	41	51	62	66	65	59	47	33	24	42
Charlevoix, Mich	21	18	25	37	52	62	67	66	60	49	36	28	43
Harrisville, Mich	19	19	24	39	50	61	66	64	59	47	35	25	42
Grayling, Mich	17	16	23	43	54	65	68	64	57	45	34	24	42

Maximum temperatures, in degrees Fahrenheit.

Station.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	No. years' record.
Bismarck, N. Dak	52	64	72	90	94	99	106	105	102	89	73	64	27
Huron, S. Dak	64	68	79	94	96	99	108	108	103	94	77	65	20
Omaha, Nebr	63	78	85	90	97	100	106	105	102	92	80	71	29
Moorhead, Minn	52	59	68	91	96	101	102	100	98	90	72	55	21
St. Paul, Minn	51	61	76	84	94	95	100	100	96	87	74	58	28
Duluth, Minn	51	58	64	81	91	92	99	95	94	80	65	54	28
Lake Winnibigoshish, Minn	52	55	60	80	92	95	103	93	90	81	67	47	10
Bayfield, Wis	50	51	60	82	89	95	104	94	94	78	64	48	9
Butternut, Wis	59	59	7[illegible]	84	95	98	100	93	94	85	71	50	5

Maximum temperatures, in degrees Fahrenheit—Continued.

Station.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	No. years' record
Grantsburg, Wis	48	52	73	83	93	98	105	98	96	84	75	58	9
Barron, Wis	48	50	65	84	90	96	102	97	92	80	68	50	8
Florence, Wis	55	60	62	82	96	98	97	92	91	80	68	51	9
La Crosse, Wis	59	65	78	86	96	98	101	101	97	88	72	61	28
Milwaukee, Wis	59	60	70	86	92	95	100	98	95	88	70	63	30
Medford, Wis	52	55	66	85	95	103	102	100	99	77	70	53	10
Marquette, Mich	56	69	70	87	98	95	108	98	97	87	69	59	27
Escanaba, Mich	49	52	58	77	84	96	95	94	89	73	65	54	26
Lathrop, Mich	49	56	58	82	92	96	98	95	96	82	60	48	13
Sault Ste. Marie, Mich	44	46	57	77	89	92	94	90	91	80	67	48	13
Alpena, Mich	52	59	77	79	95	97	98	94	94	87	67	55	23
Cheboygan, Mich	51	51	74	86	88	95	101	94	95	86	68	53	10
Harrisville, Mich	48	55	74	83	95	96	103	98	97	87	67	54	10
Grayling, Mich	50	55	65	88	98	100	101	96	94	87	71	54	10
Charlevoix, Mich	54	53	76	88	93	96	99	96	95	83	69	56	10
Grand Haven, Mich	61	59	71	84	87	92	94	92	92	82	72	61	29
Detroit, Mich	66	64	75	85	95	96	101	99	97	88	70	65	31

Minimum temperatures, in degrees Fahrenheit.

[Heavy-faced type indicate lowest temperatures ever recorded for the respective months at the places named.]

Station.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	No. years' record
Bismarck, N. Dak	−44	−43	−36	−3	20	31	32	32	**10**	**−2**	−28	−38	27
Huron, S. Dak	−43	−37	−25	7	22	31	41	33	18	3	−28	−34	20
Omaha, Nebr	−32	−26	−7	6	28	42	50	44	30	15	−14	−17	29
Moorhead, Minn	**−47**	−47	−32	**−13**	**14**	28	39	32	17	3	−26	−36	21
St. Paul, Minn	−41	−33	−22	7	24	36	45	40	28	12	−24	−39	28
Duluth, Minn	−41	−36	−26	3	25	33	45	40	29	8	−29	−34	28
Lake Winnibigoshish, Minn	−45	−40	−30	2	24	29	42	41	27	14	−29	**−45**	10
Bayfield, Wis	−30	−33	−20	6	21	25	42	37	28	17	−13	−20	9
Butternut, Wis	−42	−43	**−38**	−7	16	30	26	28	14	3	−21	−33	5
Barron, Wis	−42	**−48**	−26	−2	18	22	34	28	14	3	**−35**	−40	8
Florence, Wis	−32	−39	−18	4	17	23	36	29	19	9	−10	−21	9
Grantsburg, Wis	−42	−45	−27	−7	19	23	39	33	16	7	−32	−39	9
La Crosse, Wis	−43	−34	−23	10	29	33	46	39	24	6	−21	−37	28
Milwaukee, Wis	−25	−24	−8	12	25	38	47	42	29	16	−13	−20	30
Medford, Wis	−38	−45	−22	0	16	25	34	32	11	6	−18	−28	10
Marquette, Mich	−4	−9	−3	23	32	40	46	54	39	36	12	−1	27
Escanaba, Mich	−29	−32	−27	0	20	29	41	34	24	11	−9	−23	26
Lathrop, Mich	−27	−40	−21	0	22	24	33	28	22	10	−5	−22	9
Sault Ste. Marie, Mich	−28	−37	−27	3	24	32	40	38	28	16	−7	−19	13
Alpena, Mich	−27	−27	−19	−2	22	34	40	39	28	15	−4	−15	23
Cheboygan, Mich	−20	−38	−12	10	22	30	37	35	25	15	−6	−18	10
Charlevoix, Mich	−18	−32	−19	8	24	34	41	39	32	26	11	0	10
Harrisville, Mich	−19	−25	−10	11	24	32	40	40	27	21	2	−12	10
Grayling, Mich	−22	−41	−20	4	18	29	28	29	19	7	−6	−22	10
Grand Haven, Mich	−12	−25	−5	9	28	37	40	42	30	20	0	−12	29
Detroit, Mich	−16	−20	−7	8	29	38	48	45	30	22	0	−24	31

The tables of absolute minimum temperature answer the question, "How cold does it ever get?" For about half of the stations given in the table, observations of temperature have extended over twenty years and for the remainder of the stations for about ten years. It will be noticed that the extremes of temperature recorded at the long-period stations are not greatly different from those registered at the shorter-period stations.

The observations show unquestionably the frigid character of the weather experienced in midwinter. In fact, the lowest temperature experienced anywhere in the United States in winter is generally found along the northern boundary westward from Lake Superior to the eastern foothills of the Rocky Mountains.

It must not be supposed that these figures represent the minimum temperature reached each year; on the contrary, they mean simply that once in the whole period of observations the temperature sank to the point recorded by the figures in the table. It should also be noted that a temperature of freezing or lower has been recorded at some of the stations in each month in the year. (See the record for Moorhead, Minn.; Barron, Butternut, and Florence, Wis.; and Lathrop, Mich., the last-named station situated in the upper peninsula on a line between Escanaba and Marquette, and about equally distant from each.) The temperature record of Lathrop is rather important, since it enables one to complete a cross section of the temperature of the upper peninsula, using Marquette as a representative station on the south shore of Lake Superior and Escanaba as a representative point on Lake Michigan. The very low temperatures that occur in the Upper Lake States are the direct result of excessive radiation from a surface already cooled to a low degree by the cold northwest winds that blow out of the front of an extensive area of high pressure; the very low temperatures do not occur until the wind dies down and the sky clears. Great bodily discomfort is not experienced in the cold weather, since the air is very dry.

The absolute maximum table shows the highest point reached by the thermometer at the stations named during the observation period. The general fact exhibited by this table is that warm weather, 80° and above, need not be expected before the latter part of April, and that during the months of June, July, and August it is uniformly warm at all stations and in all portions of the Upper Lake States.

SUNSHINE AND MOISTURE OF THE UPPER LAKE STATES.

Before closing these remarks on temperature, reference should be made to the fact that the duration of sunshine in the Upper Lake States is greater than in regions farther south. This condition has an important bearing on the growth of crops. The difference is one

depending wholly on latitude, the duration increasing with the latitude; thus the possible sunshine during the month of June at New Orleans, La.; latitude 30° N., is 421 hours; at St. Louis, latitude 38° 38′, it is 446 hours, while in the latitude of St. Vincent, Duluth, and Marquette the possible sunshine is 476 hours, an excess of nearly two hours daily above that of New Orleans and one hour daily above that of St. Louis.

During the period of plant growth the important climatic features are heat, light, and moisture. We have already seen that the temperature conditions in northern Wisconsin, northern Michigan, and eastern Minnesota are practically identical with those that obtain farther west and northwest, where grains, grasses, and root crops are successfully grown. The light conditions are also similar and the duration of sunshine is greater than in lower latitudes. The conditions with respect to moisture are graphically shown on Pl. I, which portrays the distribution of annual precipitation over the region under consideration. The numerical values are given in the table following:

Precipitation, in inches and tenths.

Station.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.	No. years' record.
Bismarck, N. Dak	0.6	0.6	1.1	2.3	2.5	3.5	2.4	2.0	1.2	1.0	0.7	0.6	18.4	27
Huron, S. Dak	0.5	0.6	0.9	2.9	3.0	3.5	3.1	2.6	1.4	1.3	0.6	0.6	21.0	20
Omaha, Nebr	0.7	0.8	1.5	3.1	4.4	5.7	4.7	3.3	2.9	2.5	1.0	1.0	31.7	29
Moorhead, Minn	0.7	0.8	0.9	2.2	2.5	4.4	3.9	2.7	2.1	1.9	0.9	0.7	23.8	21
St. Paul, Minn	0.1	0.9	1.4	2.5	3.4	4.3	3.3	3.3	3.0	1.9	1.1	1.3	27.3	29
Duluth, Minn	1.1	1.1	1.7	2.4	3.7	4.6	3.7	3.3	3.9	2.6	1.6	1.4	31.1	29
Lake Winnibigoshish, Minn	0.8	1.5	1.3	1.9	2.7	4.5	4.2	3.5	3.1	2.1	0.8	0.7	27.2	15
Bayfield, Wis	1.4	1.5	1.8	2.1	2.8	3.4	3.2	3.2	2.7	2.8	1.5	1.5	27.9	11
Butternut, Wis	0.9	1.2	1.7	1.5	2.7	4.7	5.9	4.8	4.5	2.9	1.5	1.4	33.7	9
Grantsburg, Wis	1.0	1.1	2.1	2.5	4.1	4.3	3.9	4.6	3.0	2.7	1.3	1.1	31.8	11
Barron, Wis	1.0	1.3	2.0	2.4	4.1	3.8	4.1	3.1	2.5	2.9	0.9	1.3	29.6	9
Florence, Wis	1.2	1.1	1.9	2.6	4.0	3.5	3.8	3.3	2.9	2.8	1.9	1.4	30.4	10
Koepenick, Wis	1.3	1.2	1.8	2.6	3.2	3.6	3.7	3.2	3.6	3.6	1.7	1.1	30.7	11
Green Bay, Wis	1.9	1.8	2.2	2.6	3.4	3.7	3.4	2.6	3.3	2.7	2.1	1.9	31.3	15
La Crosse, Wis	1.3	1.1	1.6	2.3	3.3	4.5	4.1	3.3	4.2	2.2	1.4	1.4	30.6	29
Milwaukee, Wis	2.2	1.8	2.5	2.9	3.6	4.1	3.1	2.7	2.8	2.3	2.0	2.0	32.1	29
Medford, Wis	1.1	1.3	1.6	2.2	3.8	4.8	3.8	3.1	3.6	3.4	1.3	1.6	31.5	12
Marquette, Mich	2.0	1.8	1.8	2.0	3.0	3.5	3.0	2.9	2.9	3.3	2.7	2.5	32.4	25
Lathrop, Mich	2.0	1.5	1.8	2.0	3.9	3.3	3.4	3.2	3.5	2.9	2.3	2.3	32.2	13
Escanaba, Mich	1.6	1.6	1.8	2.1	3.4	3.9	3.2	3.8	3.6	3.3	2.3	1.9	32.5	24
Sault Ste. Marie, Mich	1.8	1.3	1.2	1.6	2.2	3.1	3.0	2.8	4.5	3.5	2.5	2.1	29.6	35
Alpena, Mich	2.5	2.0	2.0	2.2	3.5	3.7	2.9	3.5	3.8	3.8	2.8	2.5	35.1	23
Cheboygan, Mich	1.8	1.4	1.9	2.0	3.2	3.2	3.6	3.6	3.2	2.7	2.5	2.0	31.0	12
Charlevoix, Mich	2.9	1.8	1.8	1.5	2.9	2.6	2.8	2.2	3.9	3.1	2.4	2.4	30.3	14
Harrisville, Mich	2.4	2.3	2.4	2.4	3.2	3.2	2.6	4.1	3.0	3.1	2.7	2.5	34.1	20
Grayling, Mich	2.2	1.8	2.0	1.6	2.5	2.8	2.6	2.9	2.8	2.4	2.4	2.1	28.2	13
Average	1.4	1.4	1.7	2.2	3.3	3.9	3.5	3.2	3.1	2.7	1.7	1.6	29.7	

It will be seen that the annual precipitation varies from about 25 inches in central Minnesota to 35 inches in southern Michigan, although for the greater part of the area the total fall of rain and snow is not far from 30 inches, the precipitation of winter being generally in the form of snow. In Minnesota the snowfall is not so heavy as in northern Wisconsin and the upper peninsula of Michigan. The latter place receives the greatest amount of any place in the United States where agriculture is possible, and the ground is more uniformly covered with snow throughout the winter, with the possible exception of northern New England.

More than half of the annual precipitation (57 per cent) occurs in the five months May to September, inclusive, while for the six months April to September, 65 per cent of the annual fall is registered. June is the month of heaviest rainfall, and the winter months are the driest, the total for December, January, and February being but 15 per cent of the annual.

SUMMARY OF CLIMATIC FEATURES OF UPPER LAKE STATES.

The distinguishing features of the climate of the Upper Lake States may be summed up about as follows: The winter climate is cold and dry, but there is considerable snow in the northern and eastern districts. The transition seasons, spring and autumn, are characterized by frequent alternations of clear, fair skies and cloudy, rainy, or snowy weather. The fluctuations of temperature are at times sharp. The summer is warm, with long days and short, cool nights. The rainfall is generally fairly abundant and much more constant than is the case to the west and southwest. The hot, desiccating winds that so often wither and kill the growing crops of the Lower Missouri and Central Mississippi valleys are entirely absent. The air is healthful and physically invigorating to a remarkable degree.

PRACTICABILITY OF FOREST PLANTING IN THE UNITED STATES.

By William L. Hall,

Chief of Division of Forest Extension, Bureau of Forestry.

Introduction.

While it can not be said as yet that forest planting is practicable for the United States as a whole, it does apply to a large part of the country, and is of constantly increasing importance. The purposes for which forest planting is practicable differ so widely for different parts of the country that the subject will be considered here with reference to the several regions of the United States, in each of which the objects of planting are closely related.

The considerations which determine the practicability of planting as a part of forestry for any specific region are the following:

(1) The present supply of useful timber.

(2) The need of the forest to provide shelter, protect the soil, or conserve moisture.

(3) The capacity of the forest to produce another crop, either unaided by man or aided in ways less expensive than planting.

(4) The value of the ground for other purposes than forest growth.

(5) The protection which can be given from fire or other grave dangers.

(6) Indications as to a fair return on the investment.

Other considerations in the past carried great weight, though they are now largely removed. One of these was the lack of information as to the habits and requirements of forest trees, in consequence of which forest planting was merely an experiment. Sufficient information is now available to make success almost a certainty in the planting of a large number of our most valuable trees. If the individual has not the needed information he may easily get it from his more experienced neighbor or from the foresters of the State or the National Government. So, too, the question of market has become less problematic than in the past. The timber owner now has a market for many kinds of timber for which there was no sale twenty-five years ago.

As the uncertain factors in planting have been cleared away, the area for which planting is practicable has steadily enlarged. It will now pay to plant in localities where ten years ago it would have been

necessary only to encourage natural reproduction. To-day the possibility of natural reproduction on such land has gone, and only by planting may the stand be renewed. Within the next ten years, unless there is a marked improvement in the methods of handling forest lands, the reproductive power of the forest will be impaired to such an extent by fire, stock, and other injurious agents that planting will become a necessity over still greater areas.

Regions in which Forest Planting is not Practicable.

Forest planting is not practicable in those regions which are as yet well timbered, and in which the reproductive power is sufficient to renew the stand as the trees now standing are cut away. Broadly speaking, this includes in the South the hardwood region of the Southern Appalachians and the pine belt from Virginia to Texas. In the Northeast it includes the spruce forests in New York, Vermont, New Hampshire, and Maine; it includes also sections elsewhere, as in the Allegheny Mountains. In the West it includes the heavily timbered portions of California, Oregon, and Washington, and smaller sections elsewhere.

Regions in which Forest Planting is Practicable.

In other parts of the United States than those named above there are some sections in which the supply of timber is wanting or is becoming insufficient to meet the demand, and in which natural reproduction is not sufficient to insure a second crop. Fortunately, it is possible to discuss the question according to the geographic divisions—the Eastern States, the Middle West, and the Western States. For these regions it must be considered whether it will pay better to use for other purposes the land and the capital invested in planting, and import the lumber needed from other regions; whether the land can be protected from fire and other dangers; and whether satisfactory returns may be reckoned upon.

PLANTING IN THE EASTERN STATES.

In the Eastern States planting at present may be considered under the following heads: Farm wood lots, impoverished farm lands, and cut-over nonagricultural lands.

FARM WOOD LOTS.

It is the experience of both the practical farmer and the forester that it pays on every farm to maintain a wood lot for the production of timber for farm uses. The wood lot furnishes fuel, posts, poles, logs, and lumber; it shelters from wind the buildings, orchards, gardens, and fields, and in summer it furnishes shade. It is universally recognized as an essential component of the well-balanced orderly farm.

The wood lot pays well, even if it has to be located on valuable

agricultural land; but as on nearly all farms there is variation in fertility, it pays better to use the best land for farm crops and locate the wood lot on the less valuable portion, if that can be done without interfering with any of its important uses.

In the Eastern States the wood lot usually consists of a remaining portion of the original forest. Year after year the trees have been cut for fuel and other purposes until in the average wood lot the stand is now far from perfect. Not realizing the injury resulting from pasturage, the farm stock (horses, cattle, and sheep) have been permitted to range at will among the trees, with the result that no young trees have come up to occupy the ground as the mature ones were removed. The prevention of reproduction has been the most potent cause of decline in many wood lots. So important a factor in farm thrift is deserving of better treatment. Stock should be rigidly excluded and every means taken to encourage natural reproduction. But in places where natural reproduction takes place slowly, planting will be necessary. It is a good plan to permit natural reproduction to do its best, and where it fails, to plant. Where the surface of a wood lot has become compacted by long and continued tramping, and covered by a dense sod, it will be very difficult to renew the forest even by planting. Many times it will be better to start another wood lot by planting in a different place, and then, after a few years, to clear up the old one and turn it into other uses. The main thing is never on any farm to abandon the principle of the wood lot. If natural reproduction fails, plant; if one site becomes inhospitable to tree growth, try another and keep trying until the wood lot is successfully established; for on the best farms there should not fail to be from 5 to 20 per cent of the land in timber.

IMPOVERISHED FARM LANDS AND CUT-OVER NONAGRICULTURAL LANDS.

In the Eastern States are extensive areas of both of these classes of land. It is true that in some regions natural reproduction is coming about satisfactorily. For example, abandoned farm lands in the North are here and there being covered by White Pine and Spruce; in Virginia, Maryland, Delaware, and New Jersey with Scrub Pine and hardwoods; and in the South Atlantic States with Loblolly Pine. Where the process is going on rapidly enough, no thought need be given to planting. But there are wide areas in all of these States where natural reproduction is lacking, and where the land, long since cut over by the lumberman or abandoned by the farmer, is unproductive and a burden to the owner. (Pl. II.) The questions are: Can these lands be planted with assurance of a profitable return? Can the capital locked up in them be made productive? While a few of the States are owners of this class of land,[a] it is mainly a problem for the

[a] Pennsylvania, New York, and Connecticut.

private owner. On land of this character the first four considerations mentioned at the beginning are removed. The region has not now a large surplus of timber, and the land in question is without a natural reproductive tendency and without value for other purposes. The practicability of planting, therefore, depends upon the possibility of protecting the land and the return to be expected. The question of protection must be answered with respect to the individual case. Injurious insects and trespassing live stock frequently have to be dealt with, and are sometimes sources of grave danger. Fire is even a more serious menace. In some places protection from fire is easy, in others it is very difficult. Abandoned farm lands of the character described are not usually much grown up to brush, and by the cutting and plowing of fire lines they may without much cost be made quite secure from damage by fire. Where cut-over lands occur in large tracts it is usually possible to devise systems of control whereby they may be protected from fire, but where they consist of small scattered tracts in localities where fires are frequent and not controlled, it is almost useless to attempt to keep fire out, and, therefore, to plant.

For the land which can be protected there remain to be considered the cost of planting, the rate of growth, and the probable returns.

ESTIMATES OF COST AND RETURNS PER ACRE FOR PLANTED WHITE PINE.

The estimate following is intended to cover the cost and returns for 1 acre of planted White Pine in New England. The estimate is general and applies fairly to a very large section, where an area of 100 or more acres is to be planted.

The seedlings are to be grown by the planter near the tract which it is proposed to plant, and are to be once transplanted while in the seed bed. At the end of forty years from the making of the seed bed the entire product of the plantation is to be sold on the stump for box boards. The land is classed as worth \$6 per acre, and the assessed value per acre is reckoned as increasing at the rate of 75 cents per year up to the time of cutting. Taxes, which are estimated at \$1.80 per \$100, are reckoned by decades for the sake of convenience. It will require 1,210 trees to plant the acre at a distance of 6 by 6 feet. The first cost of 1,210 seedlings in seed bed, including cost of construction of the latter and supervision, is estimated at \$2. After the land is cleared, at the end of forty years, the value doubtless will be as great as at the beginning, but the value of the land is not taken into consideration. Should \$6 be added to the \$140 which it is estimated could be secured for the timber product, it would simply increase by that amount the profits of the transaction. Likewise, if the value of the land at the beginning were less than \$6, the profits would be greater by the difference plus accumulated interest. The statement following shows the items and amount of the investment for 1 acre.

Expenses on 1 acre for forty years.

First year:	
Cost of seed and starting seedlings in nursery	$2.00
Value of land	6.00
Third year:	
Transplanting to nursery, at $1 per 1,000	1.21
Fourth year:	
Transplanting to field at $4.50 per 1,000	5.45
Taxes for first decade on average assessed value of $9.38, interest to be reckoned for thirty-five years	1.69
Taxes for second decade on average assessed value of $16.88, interest to be reckoned for twenty-five years	3.04
Taxes for third decade on average assessed value of $24.38, interest to be reckoned for fifteen years	4.39
Taxes for fourth decade on average assessed value of $31.88, interest to be reckoned for five years	5.74
Total	29.52
Amount at 3 per cent compound interest	70.70

At the age of forty years the average planted White Pine in New England is 8 inches in diameter and 48½ feet high.[a]

It is estimated that the land will produce at least 40 cords of wood suitable for use as box boards, which should sell on the stump at not less than $4 per cord, bringing $160 per acre. Deducting from this sum the amount at 3 per cent compound interest, $70.70, there remains $89.30 as the return on the investment. This is equivalent to a return of about $2.25 per year from the time of planting to the time of cutting, a very satisfactory return considering the fact that it is secured from land which is useless for any other purpose, and which without a timber crop would be a source of constant expense for taxes. The timber crop not only gives a return on the money invested, but it makes productive the capital locked up in the land.

For the sake of definiteness in the estimate, it is assumed that the stand will be cut off clean at the end of forty years. In actual experience, probably the wiser course would be to leave at least half the stand for ten or twenty years longer. During this period the trees would not only grow rapidly, but the quality of the lumber would greatly improve, and in consequence it would command a correspondingly higher price.

In this estimate the cost is the record of actual experience; the rate of taxation, that at present common in New England; the rate of growth, the average of planted White Pine in New England; and the price less than that which has already been received where fair access was had to market. The estimate is corroborated by actual experience.[b]

Since the estimate is based upon present conditions, it more nearly

[a] Determined from a series of 60,000 measurements in White Pine plantations.

[b] J. D. Lyman, in The Forester, August, 1901.

applies to a plantation established forty years ago, and to be marketed now, than to one established now and to be marketed forty years in the future. In the last forty years White Pine lumber, as represented by the Detroit market, has advanced fully 100 per cent. If it should advance in the same proportion in the next forty years, the return on this investment would be proportionately greater.

While this estimate is for White Pine it is applicable to Red Pine and Norway Spruce over a large part of New England. From Massachusetts to North Carolina the Chestnut may be counted on to give commensurate returns when grown for telegraph poles and railroad ties, and likewise the Black Locust for posts.[a] In Virginia, the Carolinas, and Georgia is much land that could be planted to Loblolly Pine with indications of profit equal to the estimate. Actual examples of planting the Loblolly Pine are lacking, but its rapid growth strongly indicates great usefulness as a planted tree. Black Walnut may also be counted as a profitable tree for planting in the Southeastern States. It is adapted only to the more fertile soils, and requires from seventy-five to one hundred years to produce lumber of great value.

It happens in many cases that there are protective as well as financial considerations. Soil which erodes easily by water or is so sandy as to be blown by the wind may be retained and improved by a forest cover. A forest furnishes the best possible cover for the watersheds of storage reservoirs. For this reason fully as much as for the financial one, several water companies are planting extensively in the Eastern States. Among the most important of these are the Metropolitan Water and Sewerage Board of Massachusetts, which is planting on the watershed of its immense reservoir at Clinton, Mass., and the water department of the city of Woonsocket, R. I. (Pl. III, fig. 1). In both cases the planting is being done in cooperation with the Bureau of Forestry. The water companies supplying the cities of New Haven and Hartford, Conn., are also planting large tracts about their reservoirs under plans prepared by the director of the Yale Forest School, and the city of Middletown, Conn., is similarly planting under directions from the State forester.

The States of New York, Pennsylvania, and Connecticut have recently acquired extensive areas of nonagricultural land, and are now engaged in the work of foresting them. The State of New York especially is undertaking work of great magnitude. Within the Adirondack Preserve are about 60,000 acres of burnt-over waste land which it is planned to reforest. A beginning was made last year by the planting of 750 acres, and it is proposed hereafter to plant at the rate of 1,000 acres per year until the waste land is covered. Nurseries for the growing of seedlings are now being established.

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[a] Albert Neilson, in Forestry and Irrigation, August, 1902.

FOREST PLANTING FOR THE PROTECTION OF WATERSHED AT CLINTON, MASS.

[Courtesy of T. E. Borst, forester, Metropolitan Water and Sewerage Board, Commonwealth of Massachusetts.]

Considering the work which is being done by States, municipalities, corporations, and individuals, the present operations in forest planting in the East far exceed any similar activities in the past. Moreover, the planting now being done is based upon sound business principles, and is bound to show satisfactory returns, the effect of which will be widely extended planting throughout the Eastern States.

PLANTING IN THE MIDDLE WEST.

The Middle West can best be considered under three headings: The White Pine belt; the main agricultural region; the semiarid region.

THE WHITE PINE BELT.

Land on which White Pine has been the predominant tree occupies large portions of the States of Michigan, Wisconsin, and Minnesota. This discussion refers to those cut-over and burnt-over areas of White Pineland which, on account of their stony, sandy, or otherwise infertile condition, can not be converted into productive farms. (Pl. III, fig. 2.) That it is well suited to the production of timber, its original condition proved, and the only hope of ever making it profitable is to put it again into forest. That the present supply of White Pine is already very short is indisputable. Over large areas where it grew best it is already exhausted, and in the remaining districts it is greatly diminished. Except where recently lumbered or yet uncut, reproduction has failed. Protection from fire is as important here as on the cut-over lands in the Eastern States, and may be accomplished in the same way. For large tracts adequate systems of protection may be devised without proportionately great expense, but small tracts surrounded by land loosely administered can not easily be protected.

The restocking of White Pine lands seems to be a State rather than an individual or National problem. Conditions favor its management in large tracts for the production of standard dimension lumber. This will require a rotation of from sixty to eighty years—a period too extended for individual enterprise. The National Government could well afford to undertake the work, provided it owned the land. But land of the character in question has mainly become alienated. The States own very large and increasing holdings, on account of school grants and tax forfeiture. Probably the next decade will be marked by a systematic attempt at the reforestation of their waste land by all three of these States.

Gen. C. C. Andrews, State chief fire warden of Minnesota, speaks thus of the condition in his State:[a]

> It is estimated that there are in scattered localities, and principally in northern Minnesota, 3,000,000 acres of waste, sandy, hilly, or rocky pine forest. Hence, if

[a] Seventh Annual Report of the Chief Fire Warden of Minnesota.

the State were now to begin to plant that land with pine at the rate of 37,500 acres per year the whole would in eighty years become a well-stocked normal forest, yielding perpetually thereafter 675,000,000 feet B. M. annually. * * * Besides yielding a splendid revenue from waste lands, which otherwise would every year become more barren and useless, it would afford steady labor for thousands of people, and among indirect benefits it would tend to beautify our landscape, modify the temperature, fertilize the soil, and replenish the water supply. * * * There are remaining in Minnesota from 20 to 30 billion feet of pine, and this is now being cut at the rate of 1½ billion feet per year, and the greater part shipped out of the State. Anyone can judge for himself how long this main supply will last. The average value of standing pine in Minnesota is now $4 per 1,000 feet B. M. This value has risen $1 per 1,000 feet within the past four years. * * * From these facts it is clear that it would be wise economy for the State of Minnesota to at once begin to acquire possession of the various tracts of waste land and plant them with pine.

A preliminary survey of 1,000 acres in northern Minnesota has already been made, the planting of which will follow as soon as arrangements can be made for it. According to the plan now proposed, this is to be only preliminary to much more extensive work. A State forestry commission already exists. The next legislature will consider a bill to appropriate money for this commission and authorize it to acquire for the State land suitable for forest purposes. If this is done, active reforestation can be begun.

The State of Michigan last year set aside a tract of 60,000 acres of cut-over pine land for an attempt at systematic forestry. It is, first, a problem of protection from fire, and after that of restocking. The present growth, even where best, is scarcely more than enough to furnish seed. Mr. Thomas H. Sherrard, who represented the Bureau of Forestry in a cooperative investigation of the tract last year, has this to say in regard to the practicability of planting:[a]

Wherever protection is certain planting would become perfectly feasible. Where planting is necessary these lands could be planted with pine at an average cost per acre of not more than $8. This sum would cover the cost of raising seedlings in seed beds, transplanting to the nursery, and the final transplanting of the 3-year-old seedlings at a distance of 6 by 6 feet. Thinning and tending are considered unnecessary. The investment, at 3 per cent compound interest, would amount to $35 per acre at the end of 50 years. The value of the product at the end of this period, roughly estimated at 40 cords per acre, would be $120, assuming a stumpage price of $3 per cord. This represents a net gain of $95, or $1.98 an acre per annum. This estimate is for White Pine. The figures given are purposely conservative.

THE MAIN AGRICULTURAL REGION.

This includes the States of the Missouri, Mississippi, and Ohio valleys, between the White Pine belt on the north and the heavily forested region on the south. From this great agricultural region the most valuable timber has now largely been removed. What remains is contained principally in wood lots belonging to individual farms. The region also includes a very large area once reckoned as treeless,

[a] Forestry and Irrigation, October, 1902.

yet prodigious energy among the settlers has provided for many such sections fully as much timber as is now to be seen in some sections once heavily timbered. The Kansas State board of agriculture reports 142,984 acres of planted forest in 1900. Nebraska claims over 200,000 acres. The valley of the Arkansas River in Kansas, forty years ago entirely treeless, appears now to the casual observer to be as fully timbered as the valley of the Wabash, which was once entirely forested.

The only system of forestry practicable throughout this region is the system of wood lots on individual farms. The land is too valuable for agricultural crops to be devoted to timber culture on a large scale, but no farm is so valuable but that it would be worth more with a well-kept wood lot, covering from 5 to 20 per cent of its area. In addition to wood lots, a most sensible practice prevails of establishing protective shelter-belts and rows of trees for wind breaks in places of the greatest exposure. Such plantations add immeasurably to the comfort of the farm in addition to the timber supplies which they furnish. It is often possible in the Middle West, as in the East, to put the wood lot on the less valuable part of the farm, which is always desirable when conditions will permit it.

In addition to wood lots and protective belts, it is practicable in places in the Middle West to establish forest plantations for the production of fence posts, telegraph poles, and railroad ties, purely as a financial investment. Large plantations of Hardy Catalpa, Black Locust, Red Cedar, and Osage Orange have been established on the very best agricultural land, and compete favorably with wheat and corn as money-producing crops.[a]

THE SEMIARID REGION.

Lying between the agricultural region and the mountains, the semiarid region embraces several sections of large extent, which through the production of timber would attain a value otherwise impossible. The most notable of these sections is that containing the sand hills in west central Nebraska. They cover an area of 100 by 150 miles, which throughout is well adapted to the growth of pine timber. A large amount of land in the sand hills is yet retained by the Government. In April, 1902, the Niobrara and Dismal River forest reserves, containing altogether 208,902 acres, were established in this section for the purpose of making a systematic trial at forestation. The Department of the Interior has invited the Department of Agriculture to undertake this work, which is now fairly begun. The first planting will be done in 1903. (Pl. IV.) If inexpensive but successful planting methods are found, a large tract of planted timber should result

[a] Bul. No. 37, Bureau of Forestry, U. S. Dept. Agr., "The Hardy Catalpa," describes several large commercial plantations of Hardy Catalpa.

from the work of the next decade in that region. There are also other districts in the semiarid region which have the same general conditions and in which the Government still owns most of the land. It would be a wise policy for it to establish reserves for forest planting in all these sand-hill districts. The land is valuable for forest trees and the fact that settlers have passed over and around it for thirty years without taking it up, shows that it is valuable for nothing else.

Planting in these sections is an undertaking which logically falls to the General Government rather than to the State or the individual. The investment extends over too long a period for individual activity, and besides the Government owns most of the land. The same reasons exist, therefore, for the Government to undertake this work as for the States to undertake planting in the White Pine belt.

PLANTING IN THE WESTERN STATES.

In the Western States, where the agricultural land is limited in area, but highly developed through irrigation, forest planting will necessarily be confined almost exclusively to the mountains. It is true that in certain parts of southern California the profitable culture of the Eucalypts for timber is being carried on even on very valuable agricultural land. The climatic adaptations of this tree prevent its general use, and no other tree grows rapidly enough in that region to pay on valuable land.

The necessity of a forest cover on the Western mountains is not now doubted by anyone who has studied the conditions at all deeply. Successful irrigation depends upon a regular flow of water, which in the Western States is dependent in an unusually high degree upon the condition of the forest upon the mountains. A forest of good density acts in two ways—both beneficial. It greatly lessens evaporation and it diminishes the surface run-off, causing the water, instead of rushing off the ground in surface torrents immediately following a rain, to percolate gradually through the soil and to appear at lower levels in the form of springs.

It is often the case in the Western mountains that where the forest is needed most it is totally lacking or else is too thin to exert any appreciable influence on stream flow. This is true of very large portions of the San Gabriel and San Bernardino Mountains, in southern California, where by fire and grazing the forest has been entirely destroyed. (Pl. V, fig. 2.) Some of the best orange-producing and lemon-producing land in the United States depends upon water from these mountains for irrigation. With water it is worth from $1,500 to $2,000 per acre, while beside it is land of exactly the same character worth nothing, because there is no water available to irrigate it.

The restoration of the forest on these denuded mountains would, according to experience in similar countries, so increase the water

FIG. 1.—GENERAL VIEW OF FOREST TREE SEED BEDS, DISMAL RIVER FOREST RESERVE, NEBRASKA.

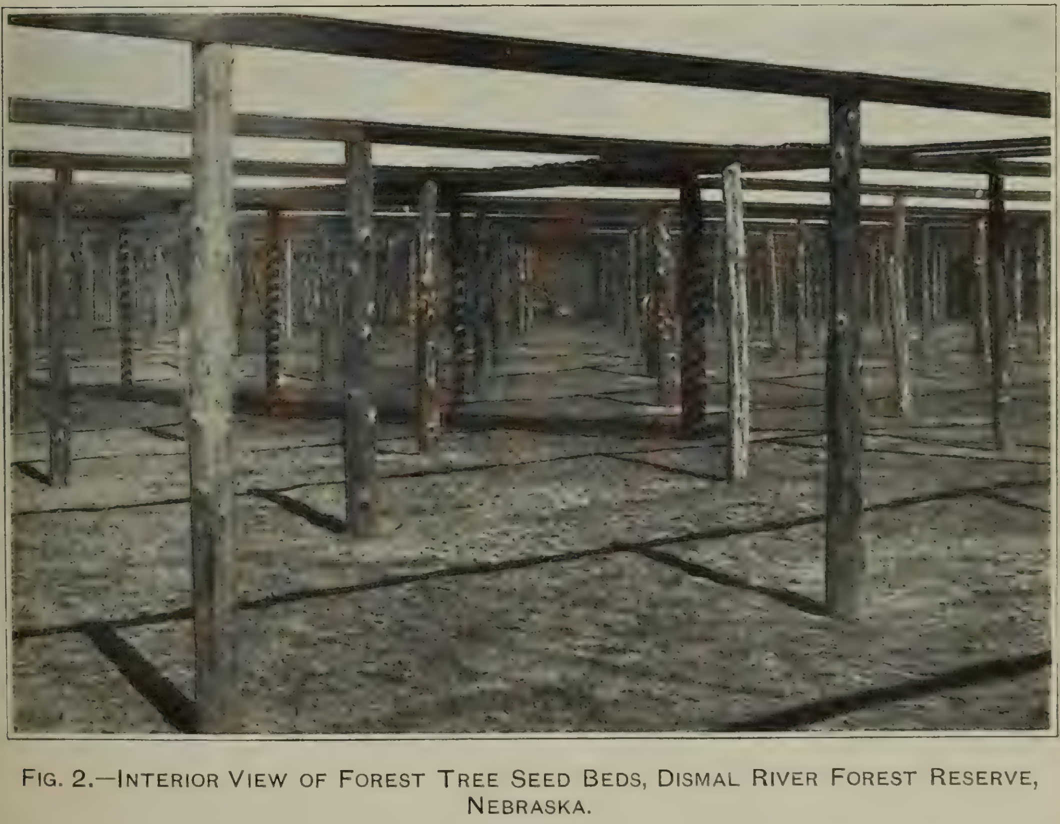

FIG. 2.—INTERIOR VIEW OF FOREST TREE SEED BEDS, DISMAL RIVER FOREST RESERVE, NEBRASKA.

supply that much more of this land could be irrigated. Increase the supply enough to irrigate 1,000 acres of this land, and the value of \$1,000,000 is created. There are many places where this result can be brought about within twenty years by planting at an expense of less than \$50,000. Under such conditions the practicability of planting is unquestionable. In a less degree this condition exists widely in the Western States.

A careful system of forest management, which involves planting on denuded watersheds, is of fundamental importance to the effectiveness of large irrigation works.

This is a work far beyond the capacity of the individual, or even the State, and belongs inherently to the National Government. Not only does the Government own the land, but in numerous cases where conditions to warrant planting exist they occur upon the National forest reserves, which are located in most cases to include the watersheds of important streams. On the reserves, of course, only the Federal Government has the right to plant. Since the Government will in the future develop irrigation systems, it will be compelled, for the protection and efficiency of its own property, to maintain such a system of forestry. Unless the barren watersheds are planted, great damage must result to the reservoirs from filling with silt, for the wash from bare mountain slopes such as are to be found in southern California is enormous.

The Government has already begun experimental planting in the San Gabriel, San Bernardino, and San Jacinto forest reserves in southern California, which are estimated by the United States Geological Survey to contain 1,447,000 acres of brush land, upon which all valuable timber has been destroyed by fire. Since the reserves were established, several years ago, the danger from fire has been so reduced by a vigorous patrol system that a large proportion of the brush land is now safe enough to warrant planting. Two or three years' experimental work has developed economical and rather rapid methods of planting, and during the past season the planting has been extended over several hundred acres by a field party of the Bureau of Forestry. Knobcone Pine has been planted on the driest spots; Incense Cedar, Sugar Pine, and Western Yellow Pine on the moister and cooler places.

In the case of the mountain slopes upon which planting is being done, the importance of a forest cover in conserving the water supply for the cities of Los Angeles and Pasadena and contiguous country is considered so great that the Los Angeles County Forest and Water Association and the Pasadena board of trade have contributed liberally toward the work. The planting gives promise of excellent results.

What the Government is doing on these reserves it might well do on a number of others in California and other Western States. There

is great need of planting on the reserves in Arizona, New Mexico, and Colorado, where natural reproduction is insufficient, and careful studies should be made as soon as possible to ascertain the best trees to plant and the right methods to follow. After that is done nurseries may be established to grow trees for the planting.

DAIRYING AT HOME AND ABROAD.

By Henry E. Alvord,

Chief of the Dairy Division, Bureau of Animal Industry.

INTRODUCTION.

To those engaged in dairy farming in the United States or interested in this industry, and who have given no particular attention to dairying in other lands, it may be interesting—in some degree instructive and perhaps encouraging—to compare the means, methods, and practices of the dairy in Europe with those of our own country. For this purpose it may be assumed that the conditions under which dairying is conducted in America are well understood by the reader. The several breeds of cattle best adapted to the dairy, their history and characteristics; the average dairy cow and the most approved methods of housing, feeding, and caring for her; that most important and delicate operation of milking; the care of milk on the farm with modern appliances; the making of choice butter and the shipping of market milk—all these matters are familiar in their detail and have been made the subject of popular publications. Issues in the Farmers' Bulletin series and other bulletins of the Department of Agriculture cover this ground thoroughly. The practice and general problem of the milk supply and milk service of large towns and cities, while less familiar to dairy farmers generally, is better known to a different class of men; but, interesting and important as the subject is, it is not proposed for special presentation in this paper. Cheese making has so nearly ceased as a farm or domestic industry and has been so generally transferred to the factory, that this branch of dairying is a comparative novelty to most American dairymen of the present day. This will therefore be referred to, although in very general terms. On the other hand, it may be assumed that the scenes and circumstances of dairying in the Old World are familiar to comparatively few, and that the opinions of one who has recently studied them in person will be accepted kindly and at their face value.

DAIRY CATTLE IN THE UNITED STATES.

Dairy cattle constitute the foundation and all-important factor of the industry. We have no dairy cattle of our own in America; we have adopted those originated in and brought from other countries.

Even our "native" or "common" stock, or "scrubs," are but mongrels of the breeds of another continent. It is impossible to estimate the debt of the dairy farmers of this country to the breeders of Ayrshires and Guernseys and Holstein-Friesians and Jerseys, in their native lands. These are the four races of cattle upon which mainly rest the present and future prosperity and progress of dairying in America. Yet, we must not forget to note the blood of the good old milking strains of Shorthorns as an excellent foundation upon which to build up profitable dairy herds. It is needless to enlarge upon the good qualities and characteristics of these distinctively dairy breeds, but it is worth noting that all of them have improved upon our hands. It may not be that the average quality of any of these breeds as they now exist in the United States is above the average of the same race upon its native pastures, but in all of them there are now on this continent animals superior to the best on the other side of the Atlantic. The breeding and management have been so good here that the cows imported and their descendants have made indisputable records as dairy performers, excelling any known in the countries from which they came. Personal observation has convinced us that we now have dairy cattle in the United States so good that nothing can be gained beyond the fancy or satisfaction in new blood by further importations from Ayrshire or any part of Great Britain, the Channel Islands, or the Netherlands.

COUNTRIES TO BE LOOKED TO FOR IMPROVEMENT OF DAIRY HERDS.

We may very properly inquire, however, whether there are cattle in other countries which would improve our dairy herds or be a valuable acquisition to the variety we now possess. Although others may hold different views, it is the belief of the writer that the only countries to which any attention can profitably be given, in this connection, are Denmark, France, and Switzerland. The first named furnishes the best example in the world of dairying as a national specialty, of rapid development, and of present high average production and excellence. Here we find the Red Danish cattle (Pl. VI, fig. 1) to be the standard stock, and very satisfactory business cows they are, of a pronounced dairy type. But they lack uniformity, except in color, particularly in udder development and other dairy points, and in the show ring the very best of them could not hopefully compete with the best of any one of the four leading dairy breeds of this country. As dairy performers they are good, but not remarkable; the best yearly records the writer has seen show an average production of 8,000 to 8,800 pounds of milk per cow, in herds of 11 to 19 animals of all ages, with an average fat content of about 3¼ per cent, an equivalent of 290 to 325 pounds of butter per year. A very celebrated herd of 70 cows averaged 7,150 pounds of milk a year. In Jutland there is a

distinctively dairy race of sharply defined black and white markings (Pl. VI, fig. 2), in appearance reminding one of Holland cattle, and still more of Brittanies, although between these two races in size. They are very attractive cows, of rather less than medium size, and excellent milkers. Both these races of Danish cattle may be credited with being economical producers; yet none of them are wanted here, for superlative excellence seems to be lacking on the one hand, while on the other they appear predisposed to tuberculosis and very generally tainted with this insidious and dread disease.

France is a dairying country and possesses a large number of so-called breeds of cattle. One can hardly say "different" or "distinct" breeds, because they seem to be largely of common origin locally differentiated and belonging to geographic districts, along the borders of which they blend in a perplexing way. Nearly all of them are what would be called in this country "dual-purpose" cattle. France prides herself upon producing all her own beef, and depends largely upon oxen for farm labor. With few exceptions her cattle are bred primarily for labor, to ultimately become (poor) beef, and dairy quality is at least a secondary consideration, only incidental in some of the breeds. Fine veal is a specialty in France, so that cattle which produce large, thrifty, quick growing, and easy fatting calves are particularly sought and are highly profitable. There are but three races of French cattle which seem to deserve consideration as dairy stock. Near the Belgian border, in French Flanders, there is a large, rather rangey cow of a pronounced dairy type and a generous and profitable producer of a medium quality of milk. These "Flamandes" are of a solid dark-brown color, sometimes reddish, and often almost black. They carry no spare flesh, have shiny coats, indicative of health, are good feeders, active, and docile. In size they are above the average, and in some respects suggest the milking Shorthorns. These cattle very justly won the sweepstake prize for dairy animals at the live-stock show of the Paris Exposition of 1900. But it is said that, although rugged enough at home, they become delicate and always deteriorate rapidly when moved away from the comparatively small district in which they had their origin or development. This accounts for the Flamandes being so little known elsewhere. In Brittany are found the pretty, active, little black and white cattle of marked dairy characteristics, producing often an astonishing quantity of milk for their size, rich in butter fat. This is a true breed, a good one of its kind, and an old one. Its blood undoubtedly entered largely into the foundation stock of the highly-prized Jersey; yet it is a race of even smaller size, some strains really diminutive. For the United States they are too small for anything but playthings. In many respects, markings excepted, they remind one more of the French Canadian dairy cattle, which have lately come into prominence, than of anything else in America. Normandy has long

been noted for its dairying, and the breed of cattle carrying the provincial name has a great reputation in France. The choicest of this race is the "Cotentin" strain, to be found pretty near the coast, from Cherbourg well down toward Brittany. In color they are red, brown, and white, spotted and patched, from two-thirds white to brindle. The best of them are large-framed, big-boned, coarse, homely creatures, fleshy, without finish or good beef form, lacking in uniformity, and generally devoid of the most highly-prized dairy characteristics. They have udders of all shapes, but few really good ones; yet some are capacious, and good cows average 8 to 10 quarts of milk a day for nine or ten months, or 5,000 to 6,000 pounds per year. It requires at least 12 quarts of milk in the winter and 14 or 15 in the summer to make a pound of butter. The annual butter product is, therefore, 200 to 225 pounds per cow; ordinarily 100 pounds a week from 20 cows, rising at times to 125 or 130 pounds. A few specimens of this breed have reached America and found favor in some quarters. But after some time spent in Normandy and an examination of many noted herds, they were decided to be a mixed, irregular, rough-looking lot of cattle, with no indications of economic dairy quality, and hardly attractive as "dual-purpose" animals. Careful comparative trials of dairy cows made in France have proved the "Normandes" to be inferior in every respect to the Brown Swiss.

The cattle of the several cantons of Switzerland noted for their dairying differ mainly in color and name. The Bernoise, Fribourgeoise, and Simmenthal cattle are all spotted, and have yellows, reds, and browns mixed with white in varying degrees and an infinity of patterns. Those with red or yellow spots usually have light muzzles and switches, while black noses and tails accompany the brown and black spots. The Schwyz breed, better known as the Brown Swiss, has been established in the United States for about thirty years. All of these Swiss cattle are exceedingly coarse boned, large framed, and heavy. They are exceedingly active for their size, famous mountain climbers, but carry a great superfluity of flesh for dairy animals, hardly compensated for by their performances at the pail. The Simmenthals are the largest, and by some preferred for milch stock, but unbiased judges generally give the Brown Swiss first place for dairy purposes. In America the last-named race has included cows which have made famous records in milk and butter production; but, as a whole, all Swiss cattle must be here regarded as of the "dual-purpose" kind, and this means that they are not expected to add much to the value of our dairy stock.

HOUSING AND CARE OF DAIRY COWS.

In the housing and general care of dairy cows no foreign country shows, as a rule, in general practice, any methods or conditions better than those of America. The average conditions everywhere are bad

FIG. 1.—PRIZE DAIRY COW, RED DANISH BREED.

FIG. 2.—BLACK AND WHITE JUTLAND BREED, DENMARK.

FIG. 1.—FARM BUILDINGS, HOLLAND. (STABLE IN FRONT.)

FIG. 2.—INTERIOR OF COW STABLE, HOLLAND. (IN SUMMER.)

enough, with opportunities for very great improvement; but such improvement is being made as rapidly in this country as anywhere. Nowhere else is there a better appreciation of the importance and economy of abundant room, light, air, dryness, comfort, and cleanliness for cows. One hears much of the close relations between the dairy cows and the families of their owners in Holland and Switzerland, connecting apartments, under the same roof, etc.; but the stables which are seen in summer converted into conservatories and rooms for weaving and cheese curing are the exceptional and show places. (Pl. VII.) Even the best of these, when visited in midwinter, with the cattle in place, are often found dark, close, ill ventilated, crowded, and insanitary in many respects, although frequently kept clean. The construction of cow stables generally in the dairy regions of the Old World is of a substantial kind, but with little regard to light and ventilation, convenience of arrangement, or ease in cleaning. The labor necessary to keep them in decent condition would be regarded as impossible in this country. The cow houses of Denmark average the best of all in Europe, but they are no better in any respect than the average of those in the distinctively dairy districts of this country, and there is here far more regard for economy of labor in management. Danish stables are generally kept clean—probably cleaner than in America—but at the cost of a vast amount of very cheap labor. In other countries, as well as Denmark, much attention is paid to cleaning the cow stables, but the conclusion has been forced upon us that this is done more from an appreciation of the value of all farm manurial matter and the fixed habit of saving it than from any knowledge or intention of cleanliness as of prime importance in dairying. This is especially shown by the fact that cows are milked in just about as careless and uncleanly a manner in Great Britain and all over Europe as, it must unfortunately be confessed, is the common practice in the United States. The very general use of women as milkers in all foreign dairy districts is a decided advantage; they are gentler and cleaner than men, and vastly better than the average farm laborer, who does all sorts of work during the day. Much attention is being given, especially in England, to perpetuate the custom of employing women instead of men for milkers, and to maintain the efficiency of milkmaids; the popular public milking contests at the dairy shows are useful and commendable. Many parts of Europe have the additional advantage of keeping the cows in the fields continuously the greater part of the year and milking them in the open air. This practice does much to insure clean milk and pure products.

FEEDING DAIRY COWS.

Very skillful feeding may be observed in many of the dairying districts of foreign countries. The owners seem to know how to obtain the maximum product from their cows with the minimum expenditure

of forage. From Norway to Italy and from Ireland to Siberia, dairymen, including the poorest peasants, do not hesitate to buy concentrated cattle foods when necessary to supplement home supplies; the purchases are made judiciously, and the feeding is equally so. But this skillful practice is almost all based upon "the rule of thumb," learned of sire by son, and passed from generation to generation. We believe that, at the present day, there is much more general knowledge of the differences and comparative value of feeds and of correct principles of feeding in this country than anywhere else, Denmark not excepted. And yet there is probably more careless and wasteful feeding of dairy cattle and animals of all kinds in America than anywhere else in the world.

THE CARE OF MILK ON THE FARM.

The care which is given to milk on the farm where produced, whether it is to go to a milk market or to be made into butter or cheese, with the location, construction, and arrangement of dairies or milk rooms, their equipment and management, show great variety and lack of uniformity in every country. The good, the bad, and the indifferent are common to all. Good milk rooms, well located, thoroughly built, shaded, cool, and well kept, are not hard to find in any dairy district. Construction is heavier and more durable in Europe; convenience and ease of management are common in America. Excepting Denmark and Sweden, no country compares with America in the general appreciation and use of cold water and ice in the care of milk. The almost entire absence of refrigeration in France, and the general ignoring of the value of cold in dairying, is truly astonishing. In the matter of dairy appliances and equipment, the United States is surpassed by no other country, although Denmark and parts of Great Britain stand about as well.

THE CITY MILK SUPPLY AND SERVICE.

The business of transporting, caring for, and distributing milk for consumption in its natural state and for household purposes seems to be in every possible stage of development in different parts of the world. Cows or their substitutes are driven through the streets and milked at customers' doors in British India and the West Indies. Milch goats are managed in the same way even in the best streets of Paris and of Rome. The milk service of villages and small towns is conducted in an exceedingly crude, yet often picturesque, manner in some of the oldest dairying regions of Europe. In Scotland, Holland, Denmark, and Switzerland milk is still carried in wooden vessels and retailed from them in towns and cities. (Pls. VIII and IX.) The local milk service in similar places in the United States is often poor enough, with little regard for care or cleanliness, but nowhere as crudely performed. In most of the big cities of Europe there are

FIG. 1.—"FARMERS' HOPE" COOPERATIVE CREAMERY, DENMARK.

FIG. 2.—COOPERATIVE CREAMERY OF NALLIERS (CHARENTE), FRANCE.

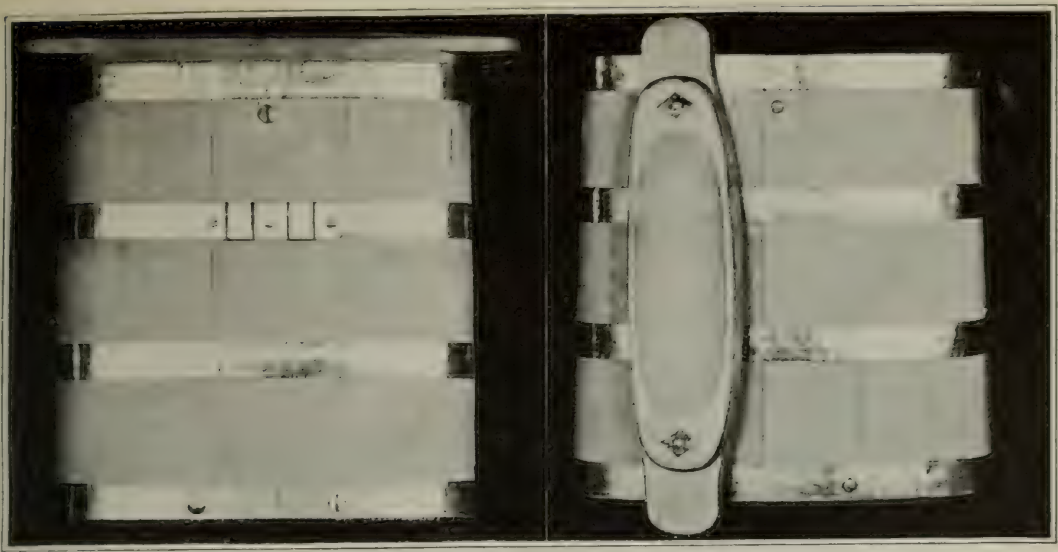

FIG. 1.—MILK CASK IN SWITZERLAND, USED SLUNG ON BACK.

FIG. 2.—MILK POTS IN NORMANDY AND JERSEY, FOR MILKING AND DELIVERY.

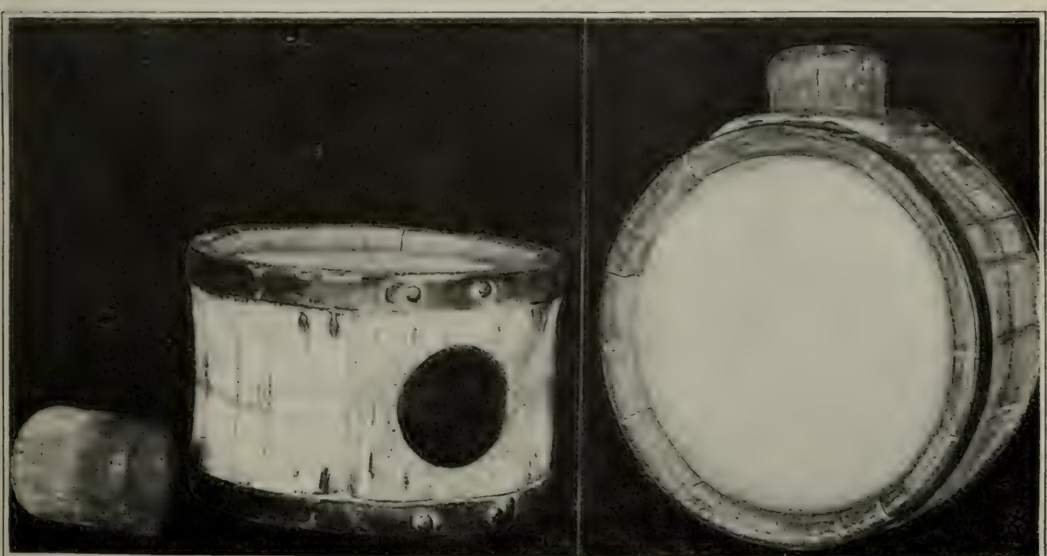

FIG. 3.—MILK CASK OF OAK, FOR SHIPMENT AND DELIVERY IN DENMARK.

large market-milk establishments, admirably conducted. There are fine ones in London, better in Copenhagen, and the biggest and best of all in Berlin. Paris probably has the poorest milk service of any of the large cities. There was a time, not many years ago, when a few foreign milk-supply establishments far exceeded in many respects the best of like character to be found in America. But at the present time, although some of these European milk companies do a larger business and have more extensive and costly plants, it is the opinion of the writer that we have in the United States a considerable number of establishments for city milk supply which are superior in many respects. Some might be named, in several different States, which are better than anything in Europe in their buildings and equipment, the efficiency of their management, and in the purity and high average quality of milk and cream served to their customers. Nowhere in the world is the important business of milk supply and milk service making such rapid and commendable progress as in the United States.

It is well worthy of note that at a special show of perishable dairy products held as an annex to the Paris Exposition, in July, 1900, just outside the city limits, where French producers had every opportunity of exhibiting their goods in the best possible shape (although under unfavorable local conditions after reaching the exhibit), there was a large collection of natural milk and cream. But the only samples of these products, absolutely free from chemical preservatives and uncooked, which were sweet and palatable after noon of the exhibition day, were from dairies in New York and New Jersey, then eighteen days from the cow! There was also in the United States dairy exhibit natural milk and cream from a farm in central Illinois, in bottles exactly as sent daily to Chicago families, which was only very slightly acid, although twenty days old. It had kept sweet until the day before this show, and even later it was better than the best normal French milk only twelve to twenty-four hours after milking.[a]

The American products had been preserved solely by cleanliness and cold; and the statement may be ventured that no milk-supply company in Europe could duplicate this performance.

BUTTER MAKING AND BUTTER MARKETS.

In butter making and the butter markets of the Old World an American dairyman may find many interesting features, but very little that is really instructive and worthy of adoption in this country. Private dairies make choice butter in Great Britain, the Channel Islands, Belgium, Denmark, and Sweden, and to a rather less degree in parts

[a] These circumstances have been stated in substantially the same language, during a speech in the Senate of France, by a senator who was president of the international jury on dairy products at the Paris Exposition, and by another person in a report to the National Agricultural Society of France.

of Germany, France, and Switzerland. In Holland butter is now so commonly adulterated and the spurious article so often passed as the genuine that the product of that country has lost its commercial standing. In nearly all other parts of Europe laws restricting and regulating "margarin" in all its forms, are strict and fairly well enforced, although there is a laxity at times in some countries. Such was the case in France during the last exposition period. The fact that fresh Normandy rolls sell at the very highest price in the London market must be recognized, and superior butter is made elsewhere in France in limited quantity; yet the average quality of French butter is not high, as a whole; it should be classed at best as second rate. Belgium is a grade higher, while Germany, Switzerland, and Italy are lower. Sweden and Finland may be placed still higher, and Denmark easily holds the position of honor. The high rank of Danish butter, due full as much to most remarkable uniformity as to superior quality, results from the general adoption of the associated or creamery system of manufacture (upon the cooperative plan), and the active aid of the Government in criticism, instruction, and supervision, amounting almost to control. Creameries are nearly as successful in Sweden and Finland. Those in Belgium, and especially in Luxemburg, are of more recent origin, but meritorious in management and production. Creameries lately established upon Danish models, and rapidly multiplying in Russia and in Ireland, are doing well, but their product ranks in quality next below those already mentioned. There are several hundred comparatively new creameries, mainly cooperative, in France and Germany, but they are of lower grade, although showing steady improvement. In considering the world's supply of factory-made or creamery butter, the excellent and increasing product of Australia and of Canada must be mentioned, both ranking but little below Danish in quality, and Argentina and Siberia are new producing territories which will make themselves felt in the near future.

In the United States there are many private dairies that make butter as fine as any in the world, and the same is true of our best creameries. The best American creamery butter is quite the equal of the best Danish, but there is no such uniformity of product, and a greater proportion of it is inferior in quality. This results from the wide extent of territory and variety in climate and local conditions which affect the 8,000 or more creameries, and the still greater differences in methods and management. There is ample room for improvement in American creameries, but the only foreign country from which they can profitably learn is Denmark. The best creameries there are models of cleanliness, good order, and systematic management. (Pl. X.) They have also taught their patrons to properly care for the milk and deliver it at the factory in prime condition. The control of bacterial growth, the practice of pasteurization, and the use of artificial as well

FIG. 1.—MILK DELIVERY FROM CASKS IN HELSINGOR, DENMARK.

FIG. 2.—MILK DELIVERY BY HANDCART IN ROTTERDAM, HOLLAND.

FIG. 1.—CHEDDAR CHEESE SHOW AND MARKET AT FROME, ENGLAND.

FIG. 2.—STREET MARKET FOR EDAM CHEESE AT HOORN, HOLLAND.

as natural cultures and ferments have been advanced well toward perfection by Danish creamerymen. All of this tends to insure the clean, mild, and delicate flavor and wonderful general uniformity which characterize Danish butter. Yet, these results are largely accomplished in Denmark through an attention to detail and an expenditure of labor which would appall an American creamery manager. It is not an uncommon thing for six or eight persons to be constantly employed there through a day of long hours in turning out a quantity of butter which is ordinarily made in this country by a man and a boy, who have all their work finished daily at 3 or 4 o'clock in the afternoon.

CHEESE MAKING.

Cheese making is a branch of dairying in which it is impossible to draw any close comparisons between the methods and results in this country and those abroad. For the production of large quantities of cheese of uniform excellence it is believed the American factory system, common to the United States and Canada, is superior to anything elsewhere, and more systematically and economically conducted. The average Cheddar cheese of the Cheddar Valley itself, of Somersetshire in general, and of the best producing districts of England and Scotland, are no better than those of New York and Wisconsin and the best of Canada. In variety and fancy cheese this continent can not yet attempt to compete with the Old World. If one would learn the bottom facts about making any of the famous specialties in cheese he must go to the locality where they originated, and where alone, often within very narrow limits, they are still made in perfection. This applies to the English Stilton, the French Roquefort and its close kinsman, the Italian Gorgonzola, the Edam and Gouda of Holland, the Gruyère and Emmenthal of France and Switzerland, the Parmesan of Italy, and the Camembert, Brie, Neuchâtel, and hundred and one other small and soft and high-flavored varieties of France and other parts of Europe, including, of course, the never-to-be-forgotten Limburger.

FAIRS AND MARKETS.

In several foreign countries there are "fairs" and markets, some only annual or occasional and others frequent and periodical, which afford novel scenes to an American. Although curious and entertaining, with many features which are commendable when local conditions are considered, there is little about these commercial methods or systems which could be advantageously adopted in this country. As examples of these unique dairy markets may be mentioned the great mart or butter exchange of Cork, Ireland, the daily auction sales of butter at the Central Markets of Paris, and the market days in many little towns and villages in Normandy, when the wives and daughters of the farmers and peasants assemble by the hundred in the parks or along the streets and sell their "mottes" of butter, often aggregating

several tons a day in a single village, to the representatives of those immense blending-butter factories in the Isigny district of La Manche. The cheese fairs at Frome, England, and Kilmarnock, Scotland, and the street markets at Alkmaar, Hoorn, and Utrecht, Holland (Pl. XI) are similarly interesting in connection with cheese.

CONCLUSIONS.

The foregoing facts and conditions as to dairying in the Old World apply mainly to countries (and districts in them) where dairying has been for several centuries one of the leading agricultural industries, if not the principal one. American dairying has been developed wholly within one century, and all of its notable progress has been within fifty years. The comparisons made show that there is little for us to learn from foreign countries to improve our dairying. Our cattle are far better adapted to their special work and more economical as dairy animals than any of the European breeds not common here. As a rule, they are better housed, fed, and cared for, with greater economy of labor, although in many instances foreign dairymen are exceedingly skillful feeders. The rents which are almost universally paid for farms in all the foreign countries named would be regarded as impossible in this country; on the other hand, hired labor for farm and dairy costs there but a fraction of what it does here. In dairy utensils and equipment ours are superior and our methods are more generally founded upon principles which are understood and known to be correct. Butter is more economically produced in the United States, and so far as the product of the creamery system is concerned, it is of higher average quality than that of any other country except Denmark; the same can not be said, however, of the farm dairy butter of this country. Europe offers a very much greater variety of cheese, including some of unsurpassed reputation, and a much more general appreciation of this product as an article of food prevails abroad. Notwithstanding the excellence of much of the European cheese, the facilities and processes of making and curing are comparatively crude. The factory system of cheese making as at present organized and conducted in America exhibits greater economy, equal skill, and more intelligence. In the important business of making milk for market, and all through the different grades of milk service, the United States is well abreast of Europe. This is true, not only in comparing averages, but, as already stated, our best establishments and most approved practices are superior to the best elsewhere in production, quality, purity, preparation, transportation, and delivery.

While too much can not be said in praise of the industry, frugality, and thrift of most of the dairymen of Europe, a close comparison leads one to feel that the conditions of this industry in the United States are decidedly more satisfactory in almost every particular.

THE SAN JOSE SCALE: ITS NATIVE HOME AND NATURAL ENEMY.

By C. L. Marlatt,

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INTRODUCTION.

Perhaps no other insect has been so widely exploited as the San Jose scale, and San Jose, Cal., its starting point in America, is known the world over by reason of its early connection with this notorious pest. The fears aroused by this insect have led to more legislation by the several States and by various foreign countries than has been induced by all other insect pests together. In fact, as a result of the San Jose scale, insects have assumed international importance and occupy a prominent place in the regulation of commerce. There is much legitimate basis for this interest and publicity, but nevertheless, serious a pest as is the San Jose scale, its importance has undoubtedly been exaggerated, and the restrictions imposed in consequence on the interchange of fruit and vegetable products are unnecessarily severe. On the other hand, some useful results have followed. Keen interest in the general subject of insect control has been aroused in many quarters, both at home and in foreign countries, where it did not previously exist, and a great increase in the numbers of practical economic workers in entomology has resulted. Valuable and effective means of controlling insect pests, notably scale insects, have been discovered, and all lines of applied entomology have been stimulated and benefited.

HISTORY OF THE SAN JOSE SCALE IN AMERICA.

The San Jose scale has been so thoroughly exploited in the publications of the Department and of the various experiment stations and in scientific, horticultural, and agricultural journals—as well as in the daily press—that a general account of this insect here would be superfluous. Only the main features of its history will, therefore, be considered. It was discovered at San Jose, Cal., in the grounds of Mr. James Lick, in the early seventies, and first spread to other orchards which had direct communication with that of Mr. Lick. The San Jose scale attacks the deciduous fruits, notably the pear and apple, and peach and other stone fruits, and certain small fruits, especially currants.

By 1880 it had extended its range rather widely about San Jose, and it was in this year studied and described by Professor Comstock, then Entomologist of the Department of Agriculture, who gave it the appropriate name of *perniciosus*, saying of it that it is the most pernicious scale insect known in this country. During the following ten or twelve years it reached all the principal deciduous fruit districts of the Pacific coast.

The early losses from it were considerable, as it is perhaps the only scale pest which, unchecked, will in two or three years actually kill, or at least ruin, the plant attacked. It was early discovered, however, that it could be practically controlled by spraying the trees in winter with a lime-sulphur-salt wash, and that, while this treatment would not effect extermination, it would keep the scale in check for a year or two, thus making it possible to grow deciduous fruits as profitably as before its appearance. Furthermore, the yearly treatment led to the general adoption in California of a short pruning and shaping of the trees, which greatly improved the quality and, at the same time, lessened the expense of gathering the fruit, and more than offset the slight cost of spraying.

Up to 1893 the San Jose scale was not known to have reached the important pear and apple districts of the Eastern and Middle States. In the year mentioned, however, it was discovered in a small orchard in Charlottesville, Va. The investigation which followed soon demonstrated that this insect had gotten into some large Eastern nurseries six or seven years before on a lot of plum trees obtained from the San Jose district in California, and had spread from these to other nursery stock, and thus had been unwittingly scattered broadcast over the Eastern and Southern States. The very great importance of this discovery was at once recognized, and every effort was made by the Department of Agriculture to locate all the places of infestation, with the idea of exterminating the pest before it had become too widely scattered, efforts which were seconded by experiment station entomologists throughout the country. The work of the first year or two demonstrated that the San Jose scale had already gone beyond the stage when extermination was possible, and efforts have since been directed toward control in orchards and nurseries by spraying and fumigation. These have been successful in that they have demonstrated that the San Jose scale can be controlled by various methods which are practical and not too expensive.

MEASURES BY FOREIGN COUNTRIES TO PREVENT INTRODUCTION OF THE INSECT.

During the first excitement which the knowledge of the occurrence and rather wide distribution of this pest in the East developed, and especially as it became apparent that it was spreading rapidly and that its extermination was probably out of the question, the alarm

thus aroused was voiced in publications of the Department and of experiment stations throughout the country, with the result that the fears awakened in the United States were transferred to foreign countries, and, beginning with Germany, one after another of the European powers, including, in addition to Germany, Austria-Hungary, Belgium, the Netherlands, France, Switzerland, Italy, and Turkey, adopted measures prohibiting the importation of American plants and fruits, or requiring rigid inspection before admission. Our neighbor, Canada, also adopted similar restrictions, and other and more remote foreign countries followed suit, such as the Cape of Good Hope, New Zealand, Java, etc. The first restrictions, especially those of Germany, were very onerous, and practically prohibited all importations of American fruit and fruit products. These have been modified somewhat, but the inspections are still very severe, and our foreign trade in plants and fruits has been much curtailed. The fears of these foreign countries were in many cases groundless or had little basis. Nevertheless, prohibitive legislation has been thus enacted against the United States, to the considerable injury of the commerce in fruits, in practically all the chief commercial countries of the world save England, although joined in by several of the more important English colonies. Within the United States also nearly every State adopted some sort of restrictive measure relative to the commerce in fruits and plants from other States, and in the main these restrictions are still operative, but with the general distribution of the San Jose scale throughout North America such restrictions will undoubtedly eventually lapse.[a]

PRESENT STATUS AND MEANS OF CONTROL OF THE INSECT.

In spite of all efforts to prevent it, the San Jose scale has slowly extended its range until it now occurs in practically every State and Territory in the Union and in portions of Canada. It is most abundant and widespread in the Pacific Coast States and in the Atlantic and Gulf States. It is less abundant in the Middle West and the central States of the northern tier. In California and other Pacific regions it is successfully controlled by the lime-sulphur-salt wash and similar applications, and in its eastern range by soap washes and kerosene or crude petroleum, either used diluted with water or pure. Recent experiments also seem to demonstrate that the California wash, which was formerly supposed not to be available under the climatic conditions of the East, may, after all, give excellent results in the Southern and Eastern States. The very natural fears early aroused by the pest are therefore subsiding, and Eastern orchardists, as well as those of the Pacific coast, have come to realize that while the San Jose scale

[a] For details of foreign and home legislation, see Circular No. 41 (second series) and Bulletin No. 13 (new series), Division of Entomology, both by Dr. Howard.

will probably be a constant feature in the growth of deciduous fruits, it is subject to remedial control and no longer is a real menace to the production of such fruit.

ORIGIN OF THE INSECT IN DOUBT.

Following the studies of Professor Comstock of this pest in California in 1880 efforts have been made to determine from whence the original infestation came; in other words, to locate the native home of this insect. The importance of discovering the origin of this scale arises from the now well-known fact that where an insect is native it is normally kept in check and prevented from assuming any very destructive features, or at least maintaining such conditions over a very long time, by natural enemies, either parasitic or predaceous insects or fungous or other diseases. Mr. Lick, in whose orchard the scale first appeared, was a great lover of plants, and imported trees and shrubs for the ornamentation of his grounds from foreign countries, and it was very naturally inferred that in some of these importations he had introduced this insect. Before this investigation started, however, Mr. Lick had died, and it was impossible to trace his importations. That the scale was not European in origin was evident, otherwise it would undoubtedly have come to this country long before with the numerous importations of stock from Europe. Its original home was, therefore, naturally placed in some Eastern country. In the course of the investigation it was found that the San Jose scale occurred in the Hawaiian Islands, in Japan, and in Australia. In the case of the Hawaiian Islands, it was conclusively shown, however, that it had been carried there on stock from California. The evidence in Australia was of a similar nature, namely, that it had come to that country comparatively recently on imported stock. Its occurrence in Japan was not discovered until 1897, and the evidence was far from being conclusive that it was indigenous in that country; nevertheless the belief that Japan was the source of this scale came to be rather generally accepted. The objections to it were voiced by Dr. Howard and the writer, in an article read before the Association of Economic Entomologists in 1899,[a] showing that at best the evidence left the question open. That this scale insect probably had its original home in China or Japan seemed, however, to be pretty conclusively indicated by the process of exclusion of other countries. Mr. Koebele's investigations of the Asiatic tropical regions and Australia and New Zealand had been fairly thorough, yet without finding it on native plants, and, furthermore, it was not known to occur in South Africa. The evidence pointing toward Japan and China was further emphasized by the fact that the San Jose scale is, by its relationship and distribution, an insect of the temperate regions rather than the Tropics.

[a] See Bulletin No. 20 (new series), Division of Entomology, pp. 36-39.

EXPLORATIONS IN EASTERN ASIA PLANNED.

With the hope of settling the disputed point of the origin of the San Jose scale, and, if the native home of the species were discovered, to study and collect and import beneficial insects to control this pest in America, the writer, in 1901–1902, made a trip of exploration in Japan, China, and other Eastern countries, lasting over a year. The accompanying map (Pl. XII) illustrates the regions explored.

EXPLORATIONS IN JAPAN.

The writer spent six months in Japan, from April to September, 1901, and in this time explored the five main islands thoroughly, from the northernmost island of Hokkaido to the lower extremity of Kiushu, the large island completing the chain on the south, representing a stretch of latitude the equivalent of from Newfoundland to Florida. The large islands of Awadji and Shikoku, rarely visited by foreigners, lying to the south of the main island, were both crossed by jinrikisha, and in the case of the larger one, Shikoku, a high mountain range was surmounted. Various trips were made across the main islands and into the remote interior, where the novel experience was several times had of being the first foreigner seen. Some weeks also were spent in the central mountain districts. In all, 42 provinces were visited out of a total of 69 in the main islands, and including the large provinces of the interior and north, thus representing a greater portion of the Empire than the numbers indicate. Altogether these explorations, it is believed, enabled the writer to make a final and correct judgment on the San Jose scale problem in Japan.[a]

The Japanese Government, through its Department of Agriculture, took the greatest interest in the investigation, and detailed to accompany the writer on his two longer trips Mr. S. K. Hori, one of the entomologists of the central agricultural experiment station, and, furthermore, commanded the assistance of the provincial agricultural experiment stations and agricultural schools and the governing authorities in the provinces throughout the Empire.

HORTICULTURAL CONDITIONS IN JAPAN.

To appreciate the status of the San Jose scale in Japan some knowledge of the horticultural conditions obtaining in the Japanese Empire is essential. Fruit growing as known in America, except in a few districts, is not carried on in Japan. Her comparatively enormous population of 46,000,000 compels the growth of cereals and other necessities of life wherever possible, and among these necessities are tea and the mulberry, the latter often grown as a hedge plant, and the

[a] All scale insects were studied and collected in the course of this investigation and the later researches made in China and elsewhere, and especially those affecting fruit trees and plants of economic importance, and, as far as possible, without interfering with the main object, other injurious insects also.

former, as a rule, on land unsuited to rice. For most Japanese, therefore, fruits are luxuries, and often, where grown in a limited way, are more for ornament and the bloom than for the fruit. The love of the beautiful manifested by these people in a thousand ways finds its commonest exemplification in the universal presence of flowering trees, notably cherry and plum, where fruit trees might be grown. These flowering trees are in every dooryard, fill the grounds of temples and parks, border streets and roadways, and are planted along the little stretches of soil dividing one rice patch from another. In the season of bloom they are almost worshipped, and famous old orchards, such as the grove of ancient plums at Mito, are visited by thousands, and during the entire month of April all of Japan is en fete and picnicking in the groves of cherry and plum in or near every city. These trees, cherished as nowhere else in the world, often attain great age, and are then strengthened with artificial supports, inclosed with handsome stone railings, and their history recorded on imposing stone monuments. Such trees become to the entomologist valuable records of 100 or 200 years' standing of insect work, or the absence of it.

For older Japan, fruit trees are grown, in the main, as dooryard plants, or in little garden patches attached to dwelling houses. Any little thatched cottage may have, in addition to its flowering cherry and plum, a single pear, peach, or persimmon tree, and also, where the climate permits, very often an orange tree. Sometimes two or three of each sort will be grown, and the more pretentious gardens of the wealthier townsmen may amount to miniature orchards, different fruit trees and ornamental plants being often jumbled together in rank confusion. In other words, the popular fruit and flowering trees, while universally grown, are very limited in number. There are in central and southern Japan, which comprise the long settled and thickly populated districts, a few orchard regions where numerous patches of from one-fourth of an acre to 3 or 4 acres of fruit trees occur. These are altogether of the old native pear (having a hard, flinty, almost inedible fruit), more or less invaded by replantings of American trees. These native trees are commonly of considerable age—from 50 to 100 years, except the replants. In this region one finds but rarely small apple orchards newly started and experimental, and more commonly small peach orchards, chiefly of native varieties. In old Japan these orchards are trained on trellises, as illustrated by fig. 1 and Pl. XIII. In the south the orange is grown to a considerable extent, also in numerous small areas. In the southern island of Kiushu there are, however, very large walnut orchards which truly compare with orchards in the American sense.

Over a considerable region in the northern end of the main island of Japan (Hondo), and on the northern island of Hokkaido, Japanese settlement and occupation has taken place only within modern times,

MAP OF CHINA AND JAPAN TO ILLUSTRATE GEOGRAPHICAL POSITION IN RELATION TO NATIVE HOME AND DISTRIBUTION OF SAN JOSE SCALE.

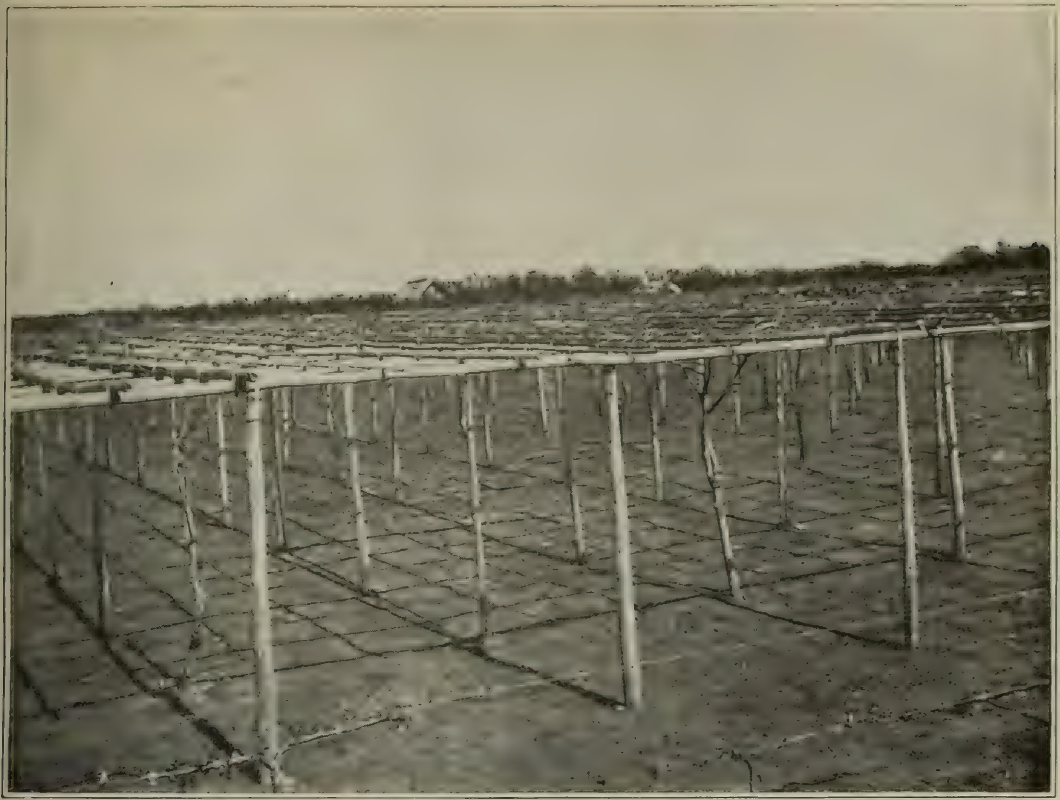

FIG. 1.—JAPANESE APPLE ORCHARD, SHOWING TRELLIS METHOD OF TRAINING.

FIG. 2.—OLD NATIVE PEAR ORCHARD OF JAPAN, SHOWING METHOD OF TRAINING.

and there are still large areas in native grass land or wild swampy or forested tracts. Throughout this region agricultural and horticultural conditions are totally different from those of the older settled portions of Japan. Horticulture especially is here modeled more directly after the American pattern. This is largely due to the work of the agricultural college at Sapporo, where for many years were American instructors and a general introduction of American methods, and the whole region, both in its fruit raising and general farming, reminds one of our own country. From the standpoint of this investigation the chief interest in this region comes from the fact that in these northern provinces of Hondo and the settled portions of Hokkaido fruit raising has been developed on a scale not equaled elsewhere in Japan. The fruit raised is chiefly the apple, and the products of this region supply Japan, and to a certain extent also the markets of eastern Asia. The apple in all this region is grown very much as it is in this country—in large orchards. The varieties are our varieties, and have been imported from America, with the exception of some few European sorts. The apple industry in Japan is of recent origin, say within the last thirty or forty years, and most of the stock has been obtained from California and from districts where the San Jose scale has long been prevalent, and much of it was undoubtedly infested when received. In the southern two-thirds of the Empire the apple is scarcely grown at all, except here and there an occasional tree. Prior to the introduction of this fruit from America it was unknown in Japan, the native apple of Japan being a crab, grown more for ornament than fruit, and a very rare tree, unknown to most Japanese.

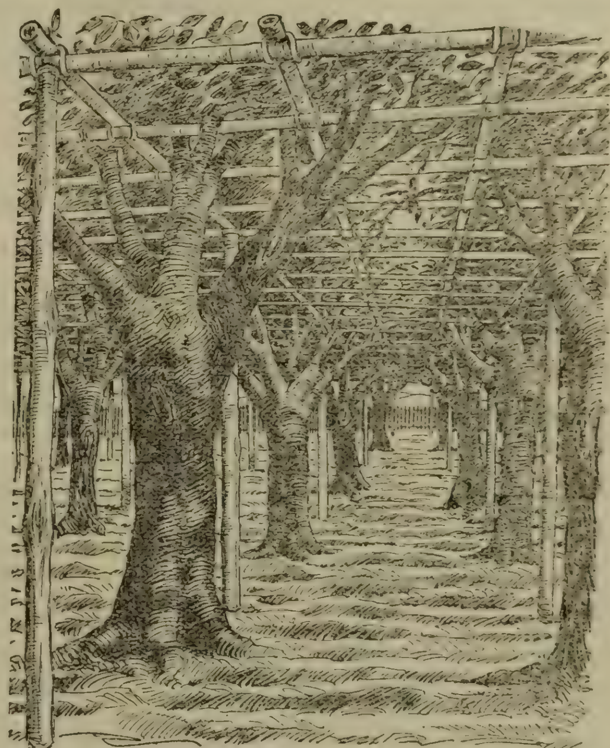

Fig. 1.—Method of training old pear orchards in Japan (height of trellis 5 feet). (Original.)

The Japanese, from the moment when they began to adopt European civilization, have been extraordinarily eager to obtain everything in foreign lands which would be a benefit to them, and at an early day the introduction of foreign fruits was begun. The only commercial result so far has been the apple industry, just described, of north Japan. Nevertheless throughout the Empire one finds an astonishing

number of places where limited experiments with American fruits, dating only a few years back, are being carried on in private gardens, and as replants in the old pear orchards. Practically all of this stock, like the apple, came from California, and was undoubtedly infested when received, and often the scale is still confined to these trees or has spread very slightly from them. Furthermore, the chief sources of nursery supplies in Japan are three large establishments, or nursery districts, and these three have been instrumental in introducing and scattering these new varieties of fruits. These nurseries are now, and have been undoubtedly for several years, infested with San Jose scale from the American stock, and have been the means of spreading the scale all over the Empire. In nearly every case in central and southern Japan where the San Jose scale was found it was on stock obtained from one or the other of these three nurseries, two of which were investigated by the writer, and the conditions of the third were made known to him by Mr. Hori.

THE SAN JOSE SCALE A RECENT INTRODUCTION INTO JAPAN.

All the evidence obtained points to one conclusion, namely, that the San Jose scale is a comparatively recent importation into Japan from the United States. Direct evidence exists that wherever the San Jose scale is found in Japan it has been brought in recently on young nursery stock. Very often in south Japan, where the introduction of new stock is of late beginning, the San Jose scale is still confined to the introduced trees, or has spread very slightly to the old native trees, notably the Japanese pear. In no case was the San Jose scale found on these native trees where there was not ample opportunity for it to have come to them from the new stock. In north Japan the apple orchards were mildly infested with the San Jose scale, exactly as would have been anticipated from the history of this industry. Throughout the Japanese Empire, however, where there had been no introduction of American trees, the San Jose scale was absolutely wanting, and this was especially notable in the remoter smaller islands, where few if any such introductions had been made, and in districts where no new stock had penetrated. Furthermore, the interior mountain regions, which some had thought might be the original home of the scale, were found to be entirely free from this insect.

Growing in every city and hamlet and farmyard throughout the Japanese Empire are plum, cherry, pear, and other deciduous trees which would be the natural food of the San Jose scale, and on these trees, if it were a native species, it should occur at least scatteringly, kept in general check by the balance maintained by long-standing natural enemies. In point of fact this is exactly the condition of affairs with three other scale insects in Japan which are undoubtedly native and are parasites on these same trees—the pear Leucaspis and

Parlatoria and the Diaspis of the plum, peach, and cherry. All three of these insects occur throughout Japan, scarcely missing a tree, even in the remoter provinces and small islands. They are very rarely in sufficient numbers to be serious pests, being kept in check by natural means and exhibiting a condition which one would naturally expect in the case of native species. If the San Jose scale were native in Japan it should present the same conditions, which, as already shown, it distinctly does not.

It has been suggested that the scarcity of this scale on native fruits is due to the natural resistance of such plants to this insect. This belief is without foundation. The native pear trees, when the scale is brought to them by new stock, are subject to infestation quite as severely as the foreign varieties. In the case of old gnarly trees of a half a century or more's standing the chance of great infestation is of course less, as it would be under the same circumstances with old trees in America; but the young stock suffers just as much as foreign trees.

Anyone studying the San Jose scale in Japan at present without a knowledge of the horticultural history of the country, and especially its recent development, as indicated above, might very readily and naturally be deceived by the present distribution of this scale insect throughout the islands, as one might similarly be deceived by the study of the present conditions in America. But an appreciation of all the facts concerned demonstrates at once the recent entrance of this insect into Japan.

Confirming this decision, it should be remembered that the San Jose scale was not known in Japan until 1897, although in the apple districts of northern Japan it is now recalled that there has been considerable difficulty with this same scale since the introduction of this fruit. Mr. Albert Koebele, one of the best collectors of scale insects who has ever been connected with the Department of Agriculture, spent some time in central Japan in 1895 in the interest of the Hawaiian Government, and failed absolutely to find the San Jose scale.

Furthermore, the fruit, flowering, and ornamental plants of Japan have been steadily shipped to America and Europe in enormous quantities for more than half a century; in fact, even prior to the opening of the country by the treaty signed by Commodore Perry in 1854, the celebrated naturalist Dr. Von Siebold had been established twenty-five or thirty years at Nagasaki making the studies which resulted in his Flora Japonica, and had built up an extensive nursery establishment from which Japanese plants of all sorts were shipped for years to Europe. Mr. Robert Fortune, in 1860–1861, traveled in Japan and shipped enormous quantities of Japanese flowering and ornamental trees and plants to England, and since that time the exportation of Japanese plants has gone on without cessation and in constantly increasing amounts. If the San Jose scale had been a native species

in Japan, it should long since have had world-wide distribution from Japanese sources alone. The absurdity of the belief, therefore, that Japan is the original home of this species is evident.

EXPLORATIONS IN CHINA.

The investigations up to this point, while freeing Japan from the onus of having given the San Jose scale to the world, left the problem unsettled as to the original home of this insect. China, as indicated in the introductory paragraphs, remained the only probable place of origin. In Yokohama and elsewhere the writer was fortunate enough to meet a number of English and German and American residents of China who were spending the summer months in Japan, and from them was able to get what is not given in any of the books—an idea of the fruit-growing conditions of China and the locations of the principal fruit districts.

HORTICULTURAL CONDITIONS IN CHINA.

In brief, it may be stated that deciduous fruits are grown from the Shanghai region northward, the peach being practically the only fruit grown to any extent about Shanghai. The great apple district of China is the region lying back of the city of Chifu in the north, an industry started many years ago by a missionary, Dr. Nevius, and now assuming very considerable proportions, having spread over quite a large province. Fruit from this region is now found in the markets of all central and southern China. In the provinces south of that in which Shanghai is situated the orange and other subtropical fruits take the place of the deciduous fruits.

INVESTIGATIONS IN NORTH CHINA.

The writer's explorations in China included a considerable investigation of the region about Shanghai, a trip north to Chifu and to Pekin, and the district lying between the latter city and Tientsin and Tungku. At Chifu an exploration was made on horseback through the fruit districts lying back of the city, a good many orchards being visited, notably the original orchard planted by Dr. Nevius, and the gardens and smaller orchards immediately surrounding his residence some distance outside of the city. Most unfortunate for the history of the fruit development of this region and of the native fruits of this part of China was Dr. Nevius's recent death. His widow was unable to give the writer any information except that the doctor had been very active as a horticulturist during all his long residence there (thirty years), and had been the exciting agent in the development of the fruit industry of that region. His stock had mostly been obtained from America, and American varieties of apples and pears are being grown in the province. Throughout this region was found a mild infestation with San Jose scale, its occurrence here, however, throwing

FIG. 1.—PONY FRUIT CART IN WHICH PRODUCTS OF THE HILL COUNTRY ARE BROUGHT INTO PEKIN, CHINA.

FIG. 2.—PORTION OF STREET DEVOTED TO SALE OF FRUITS IN PEKIN, CHINA.

[In foreground, fruit samples; in background, storehouses, also dromedaries employed to bring products from remote provinces.]

FIG. 1.—PORTION OF WHOLESALE FRUIT AND NUT STREET IN PEKIN, CHINA, SHOWING NUT PRODUCTS, CHIEFLY PEANUTS.

FIG. 2.—A NATIVE FRUIT STAND IN CHEFOO, CHINA.

no new light on the subject of origin, on account of the fact of the importations from California of the original stock, and its dissemination over this province. The fact that this scale insect was not very troublesome in this region was, however, significant, and was evidently due to the general presence of a predaceous ladybird.

The next point examined after Chifu was Tientsin, and the region lying between this considerable city and its port town of Tungku, after which the trip was continued to the capital city of Pekin. Much of the region of China bordering the Gulf of Pechili is perfectly level and flat, and raised only a few feet above the ocean. It is devoted to the growth of cereals, wheat, barley, and millet, and orchard plantings are practically wanting until one gets into the hill country lying to the north and west, leading up to the Great Wall. Personal investigations of this region were confined to the district about Pekin and between Pekin and Tungku. The United States minister at Pekin, Mr. Conger, kindly offered to furnish an escort of Chinese soldiers in exploring the mountain region north of Pekin, but the writer was able to satisfy himself of the conditions without undertaking this trip, which at this season of the year (October) would have been almost impossible, and, in view of the unsettled state of the country, attended with considerable risk.

The facts of greatest interest learned here were obtained in the markets of the city of Pekin. Pekin is the center and market for all the region lying to the north and west, and the streets devoted to the sale of fruits in the Chinese city are one of the sights of Pekin. The fruit and nut products are brought into Pekin in the little two-wheeled carts, or more generally on camelback, great caravans of heavily loaded camels and streams of carts constantly entering the city with the products of the outlying provinces. One finds, therefore, in the markets of the Chinese city the fruit products of all northern China, and there they can be studied at ease. Pls. XIV and XV show views taken in these market streets.

The conditions under which this fruit is grown was learned from engineers, officers, and others who had explored the region in question. All of the district lying between Pekin and the Great Wall to the north, west, and east has been very carefully explored by the foreign military authorities, and maps which amount to local road maps of the whole country have been made. From various individuals employed in this minute survey a great deal was learned relative to the fruit growing of the district indicated. Much fruit is grown south of the Great Wall, chiefly along the protected valleys running southward and eastward from the mountain chain which this wall dominates. These fruits are native apple, pear, and peach, and a little haw apple which grows wild over the hills. Quantities of these fruits were examined, with the exception of the peach (which was now out of season), in the

markets of Pekin, and later at Tientsin. Throughout this region no foreign introductions of fruits or fruit trees have ever been made, and the fruits in the market are all of the native sorts. The pears are little and hard, somewhat like the native Japanese pear in firmness, but elongate instead of spherical. The apples are what we term crab apples, even the largest; and the smaller ones, which are the most numerous, are not much larger than marbles and of a brilliant red. The haw apple is shipped by thousands of bushels to Pekin and southern ports. It is of about the size of the small crab apple just mentioned, and also a deep red, somewhat obscured, however, by a downy pubescence. This haw apple is much esteemed by the Chinese, and the United States minister, Mr. Conger, spoke very highly of the jelly which is prepared from it. It is the most abundant fruit seen in all markets of north China, and is taken as far south as Hongkong.

THE NATIVE PLACE OF THE SAN JOSE SCALE DISCOVERED.

A great many bushels of different fruits were examined, and the red crab apple, haw apple, and pear were found infested with a scale insect which resembled exactly the San Jose scale, and was later identified as such. Perhaps one apple in a hundred would have a few of these scales about the blossom end, and about the same proportion was true of the haw apple and native pear.

The finding of the San Jose scale scattered over these fruits in the Pekin markets was a very interesting discovery. The haw apple, as just noted, is a wild fruit growing on the hillsides of this section of China. The native crab is the apple which has been grown in this region from time immemorial. The occurrence of the San Jose scale on these two fruits and on the native pear also has but one explanation—that in this region this insect is native. Its scattering occurrence is what one would expect under the circumstances, for in a region where a scale has always occurred it reaches a balance with its natural enemies, so that it is rarely, if ever, injurious.

These examinations caused great excitement among the Chinese market people, no possible explanation occurring to them for this curious and unusual conduct, overturning their baskets of apples, handling the fruit, and taking out one specimen from every hundred or two; invariably a great crowd of excited Chinese was attracted. Occasionally a man was found who could speak a little pidgin-English, and then the only explanation which they seemed to understand was offered, namely, that the writer was seeking certain minute insects of exceptional value as medicine. The minute scales were pointed out and they were allowed to examine them through the lens. The use of insects for medicine being common in China, this explanation at once reassured the Chinese as to the writer's sanity, which undoubtedly had been questioned.

The conditions indicated in the markets of Pekin were substantiated by examinations in Tientsin. Pekin was an utterly destroyed city, and very little of residences or gardens was left for examination. Tientsin was little injured by the war, and here a good many gardens were examined. Fruit growing in this region, however, does not occur to any extent, and the gardens exhibited chiefly ornamental plants, notably the Chinese flowering peach, which is grown solely for its bloom, its fruit being diminutive and inedible. This peach was scatteringly infested with the San Jose scale. At Tientsin, through the courtesy of the German medical authorities, the writer was enabled to make a microscopical examination of his collections, and this demonstrated beyond question that they represented the San Jose species.

CONDITIONS IN CENTRAL AND SOUTH CHINA.

After another short stop at Chifu, Shanghai was visited once more and a thorough examination of the peach-orchard district lying to the west of the city was made. In the orchards not a trace of the San Jose scale was found. Later in an examination of several of the small Chinese nurseries and gardens in and about the city the San Jose scale was found on some young stock in one of the nurseries. The scale was dying out, however, and evidently the climate of Shanghai and southward in China is not one which it can successfully endure. The difficulty is probably due to the excessive heat and the accompanying great moisture of the rainy season of summer, which develop fungous disease and exterminate the scale. This is further indicated by the fact that the plants of this whole region are notably free from scale attack, or where scale is present it shows fungous disease.

Later a trip was made into the interior from Shanghai by house-boat, peach orchards and house plantings being examined en route, but without finding a trace of the San Jose scale anywhere, nor any other scale insect on deciduous plants except an occasional very slight infestation, represented by a few specimens only, of *Diaspis pentagona*.

Below Shanghai one gets into a subtropical climate, and the orange, pomelo, and mandarin take the place of deciduous fruits. Entomological explorations were continued very briefly at Hongkong, in south China, where in the markets were found the haw apple and crab apple from north China, and with considerable thoroughness in the British Straits Settlements about Singapore and in Java, and later in Ceylon and the various points touched en route home. The San Jose scale story, however, ends with Shanghai.

FAILURE OF THE SCALE TO REACH JAPAN FROM CHINA.

The question immediately suggests itself, Why was not Japan early infested with this insect from her near neighbor, China? This would be expected as the natural and early result of the contiguity of the two countries. The explanation is forthcoming when the history of

the political relationship of these two countries is considered. The natural antagonisms and jealousies of rival races have kept China and Japan apart in the past, and commercial and friendly intercourse has been practically wanting. Japan, it is true, has taken her alphabet and much of her learning and civilization from China, and, some 600 years after Christ, the Buddhist religion, which now divides honors with the native Shinto religion. All this has come to Japan, not from China directly, but through Korea. Japan conquered Korea very early in the present era, 200 A. D., in the reign of the famous Empress Jingo, and has ever since claimed and exercised a greater or less sovereignty over the country. Reference to the map of Asia (Pl. XII) indicates, furthermore, that Japan is not directly opposed to China, but to Korea and what is now Russian territory and Manchuria, or the portion of Asia which the Chinese themselves designate as the "cut-off region," separated from China proper as it is by mountain ranges, the Eastern Gobi, and the Great Wall. If Japan obtained any deciduous fruits from the continent, they came from Korea and not China. The orange and subtropical fruits were brought from the south, and in more modern times whatever trade has been carried on with China through the agency of the Portuguese and Dutch has been with the southern ports, where the San Jose scale does not exist.[a]

The general absence of commercial intercourse between these two countries accounts for the failure of an insect common in the region north of Pekin to reach Japan. Furthermore, it may be said that the Chinese trade which has sprung up so actively in later years with Japan has been, so far as fruits and trees are concerned, solely with the region from Shanghai southward, and the introduction of fruits and the like has not been from China to Japan, but the other way, and it is quite possible that the San Jose scale found at Shanghai was exported from Japan on stock sent over to the local Chinese nurserymen.

As a matter of interest, it may be noted that the native home of the San Jose scale in China is a fairly well shut-off region, and this accounts probably for the failure of this insect to become a world pest ages ago. The district in question is the hill region leading up to the mountains and Great Wall, and comprises the northern and northwestern frontier of China proper. Beyond the Great Wall on the north and west lies Mongolia, consisting chiefly of the vast Desert of

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[a] For several hundred years prior to Commodore Perry's mission in 1854 Japan maintained her isolation from the outside world by the enforcement of the strictest prohibitions. Foreign travel on the part of her subjects was not allowed, and to prevent any of her people wandering beyond the immediate confines of the Empire the building of boats exceeding a very small size was prohibited. In no sense, therefore, up to this time, had Japan any foreign commerce save through the yearly boat which the Dutch were allowed to send to their little island colony of Deshima in the harbor of Nagasaki.

Gobi; to the northeast and separating the region from Manchuria and Korea is the Eastern Gobi; to the south and east lies the great alluvial plain, the product of centuries of mud carried down by the Yellow River, a region where cereals only are grown. These are all effective barriers, and especially so when considered in connection with the political conditions of the past. The alluvial plain on the southeast is not now and seems never to have been devoted in the least to fruit, excepting a few vineyards, and farther south the climate becomes unfavorable, as already noted. We have, therefore, as the original home of this insect a naturally shut-off area from which it could not easily escape under the conditions prevailing up to our own times. (See map, Pl. XII.)

PROBABLE MEANS OF THE SCALE GETTING TO AMERICA.

The means by which the San Jose scale came from China to America is a matter of interest and offers room for conjecture. The San Jose scale apparently reached California on trees imported by the late James Lick. It has already been stated that this gentleman was a great lover and energetic importer of trees from foreign countries, and it is the writer's belief that he imported from China, possibly through Dr. Nevius or some other, the flowering Chinese peach, and brought with it the San Jose scale to his premises. At any rate, the writer believes that this insect, which should now be known as the *Chinese scale*, came to this country on some ornamental stock from north China.

THE ASIATIC LADYBIRD, THE NATURAL ENEMY OF THE SAN JOSE SCALE.

One of the most interesting results of this investigation was the discovery that a little ladybird (*Chilocorus similis*—figs. 2 and 3) was everywhere present in both China and Japan, feeding on the San Jose scale and also on the white peach-scale (*Diaspis pentagona*), the latter another serious scale pest which has recently gained foothold in this country, and is undoubtedly native also to eastern Asia, extending, as it does, from north China southward through the Malay Peninsula to Java, and occurring throughout Japan. Wherever either of these scale insects occurred the little ladybird was found industriously feeding upon them. This ladybird, like other members of its genus, is a general feeder, and will attack almost any scale insect. It was very evident, however, that it fed on the San Jose scale with even greater readiness than it did on the Diaspis or other scale insects, and later on, in the experimental breeding cages in Washington, D. C., it has multiplied more rapidly on the San Jose scale than on the Diaspis. In Japan this ladybird, already present as an enemy of the widely distributed Diaspis, has taken very readily to the San Jose scale and assists very much in keeping the latter in subjection.

INTRODUCTION OF THE LADYBIRD INTO THE UNITED STATES.

After finding this ladybird so generally present with the San Jose scale and apparently so efficient in keeping the latter within reasonable limits, the desirability of introducing it into America was very evident, and before the writer had left Japan he had collected and shipped several boxes of this insect to Washington.[a]

Of the 150 or 200 beetles which the writer shipped from Japan and China to America not more than 30 arrived in Washington alive, and all but two of these perished during the winter. In shipping these beetles they were placed in small wooden boxes packed full of scale-infested twigs and sent through the mails, with the exception of one package, which was personally taken across the Pacific by Miss Laura Bell, and mailed in Vancouver. The shipments, so far as they could be controlled, were made to catch the Canadian Pacific steamers to obtain the advantage of the northern and much cooler as well as shorter passage. Nevertheless, it probably took from four to five weeks for the material sent from Japan, and a week or more longer for the material sent from China, to reach its destination. The high percentage of mortality may also be accounted for by the probability that a good many of the beetles when collected were old and spent individuals.

Fortunately, however, one at least of the two survivors was an impregnated female, and began laying eggs in early April. From this individual, the other one being presumably a male, at least 200 eggs were obtained, not counting a good many that were thrown out with the scale-covered wood on which the beetles were being fed before the eggs were noted. After some hundred larvæ had been obtained indoors, the beetles were placed on a large plum tree in the experimental orchard and protected by a wire screen cage covering the tree. All of the indoor-hatched larvæ were afterwards transferred to this tree, and before the death of these imported insects, about the end of May, more than 200 larvæ were in various stages of development. From this beginning the stock increased very rapidly, and to accommodate them several other large cases (Pl. XVI) were constructed, covering pear trees infested with San Jose scale, and by midsummer many beetles were liberated in the orchard. During August, 1902, shipments to various eastern experiment stations were begun, in all perhaps, 1,000 specimens being thus sent out, and reports have been received of considerable breeding success from some of these

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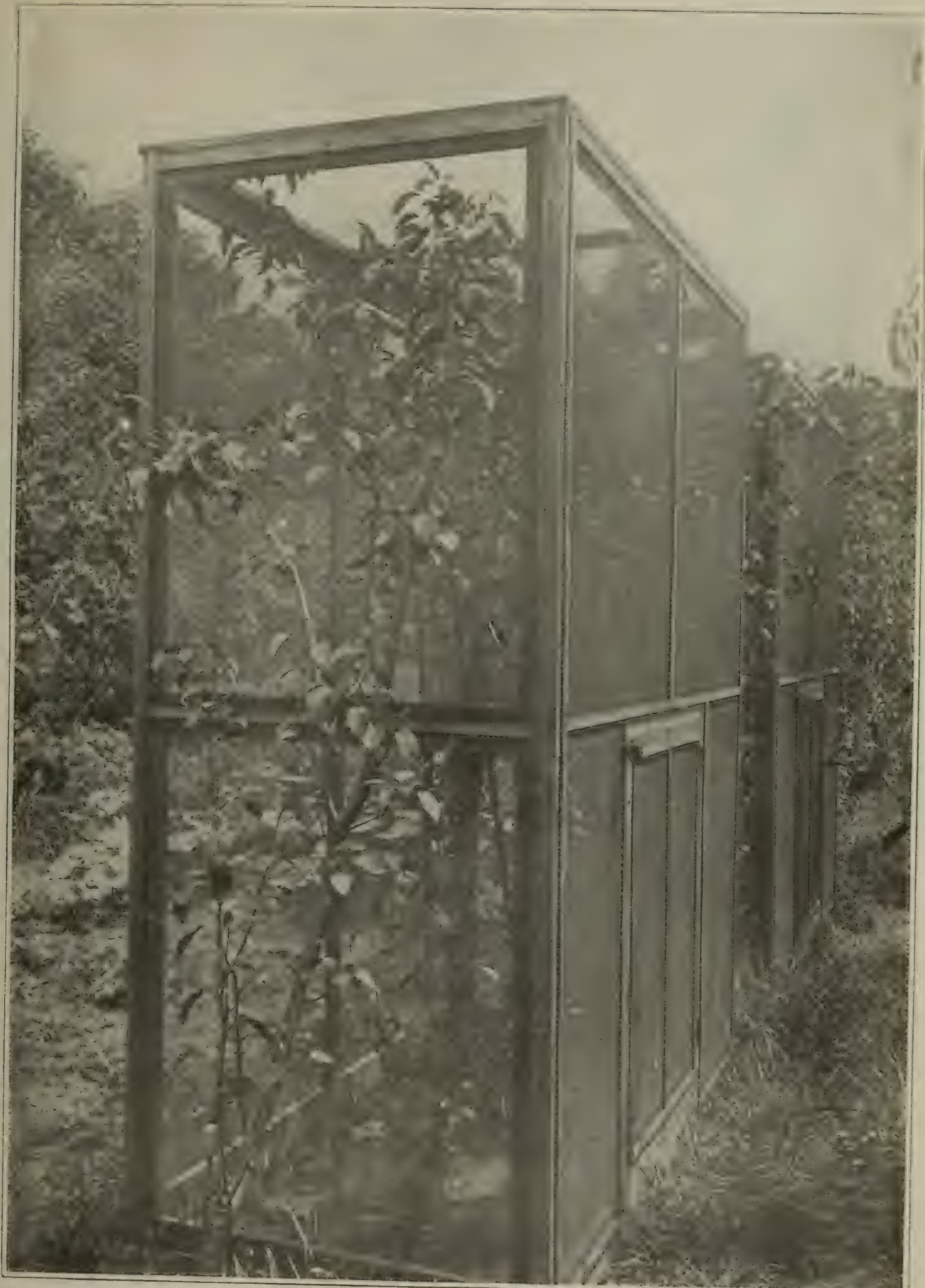
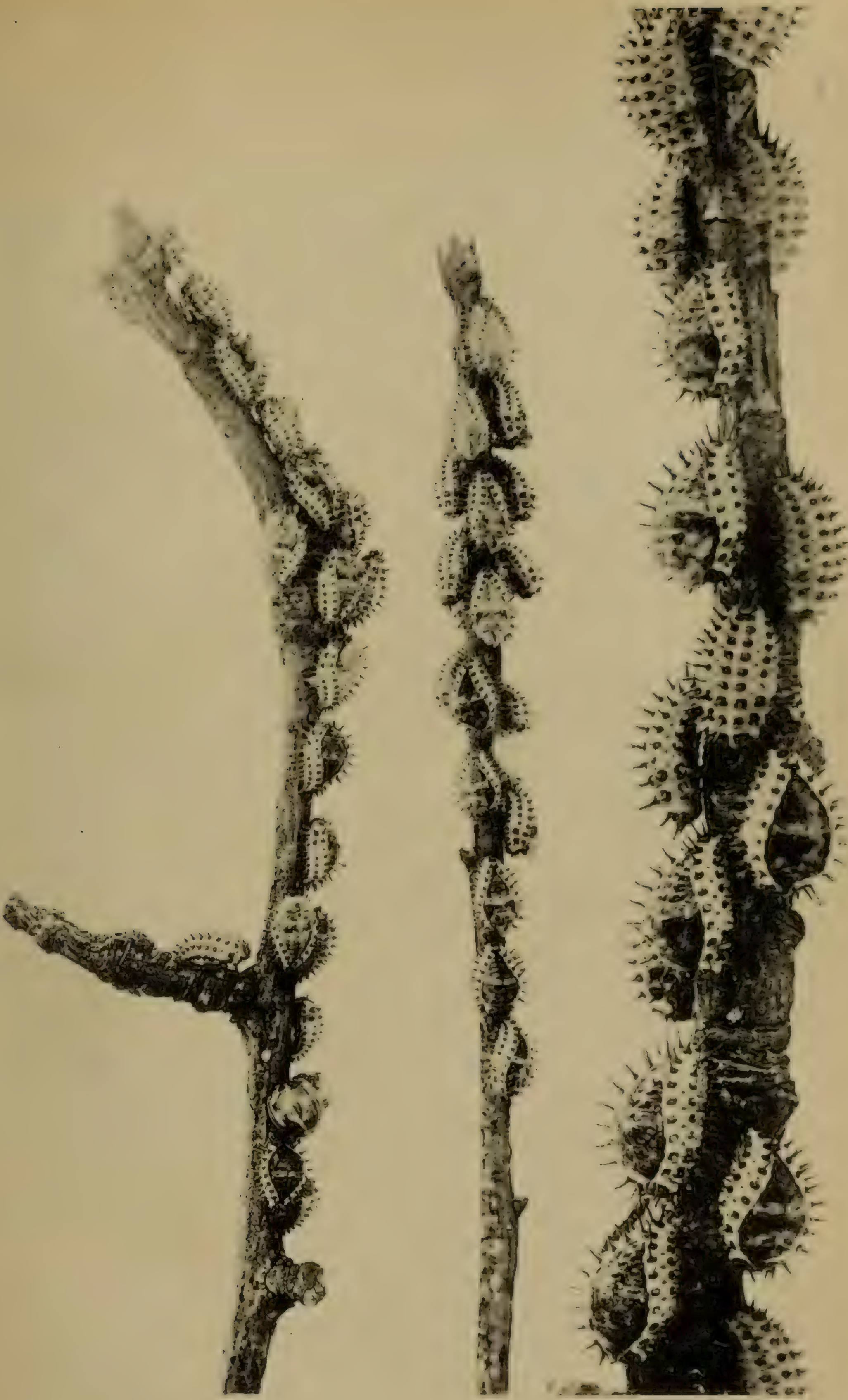
[a] *Chilocorus similis* was collected in Japan by Mr. Koebele in 1895 and sent to California, but nothing is known of the outcome of this experiment. Prof. J. B. Smith had specimens of miscellaneous ladybirds, among which was this species, sent to him by some Japanese correspondents in 1898, and liberated them in an orchard in New Jersey. Nothing has been seen of these insects since, and Professor Smith believes that they perished. Judging from the small percentages of survivors of those which the writer imported, it is very likely that those sent over to Professor Smith all died during the winter.



CAGES USED IN BREEDING ASIATIC LADYBIRD (CHILOCORUS SIMILIS).



THE MERIDEN GRAVURE CO.

PUPATING LARVAE OF CHILOCORUS SIMILIS ON THE TERMINALS OF TWIGS IN DEPARTMENT ORCHARD.

shipments. At the close of the first summer there were in stock some thousand, perhaps, of these beetles, 500 retained in cages, and the rest free in the little orchard attached to the insectary and elsewhere on the grounds of the Department of Agriculture. The numbers of the last brood are illustrated by the photographs reproduced on Pl. XVII of pupæ on twigs from the Department orchard.

CHARACTERISTICS OF THE ASIATIC LADYBIRD.

The rate of multiplication of this insect is most satisfactory. It has at least four broods in a summer, and a single female will probably produce 500 young, at least 200 having been secured from an imported specimen under unfavorable conditions, not counting the loss of a good many eggs.

The egg-laying habits of this beetle are somewhat peculiar. The egg is normally concealed under an adult female scale. The parent beetle selects a suitable scale, drags out the scale insect underneath it, turns about and thrusts the ovipositor under the slightly lifted edge of the scale, and in two or more minutes deposits a single egg in the cavity, very often slowly masticating, meanwhile, the scale insect which has been made to yield its place for the egg. This habit of oviposition seems peculiar to this species, and does not correspond to the closely allied native species. It was found later on, however, when beetles became numerous, and especially during the period when old female scales were not abundant, the trees being covered with young scale insects, that other locations would be chosen by the beetle for oviposition, such as beneath a loose edge of bark, or, more rarely, eggs would be deposited exposed on the bark. The general characteristics of the egg, larvæ of different stages, and the adult beetle are shown in the illustrations.

ASIATIC AND ALLIED NATIVE SPECIES COMPARED.

This ladybird is very closely allied to a native species which occurs in this country and which is a very efficient agent in controlling our native scale insects. Superficially, the native species (*Chilocorus bivulnerus*) closely resembles the Asiatic species, and the adults can not be distinguished without the most critical examination. Both are shining black, hemispherical, a little more than one-eighth of an inch across, and marked with two bright red spots. The imported species is somewhat smaller than the native species, and differs slightly in being rather more brilliantly colored and in the general shape and convexity of the wings and thorax. The larvæ of the two species, however, are distinctly different in general appearance. The Asiatic species has a skin of a reddish or flesh tint, the spines being black, but less prominent than in our native species. The general color of the latter is a dull gray, and the black spines give it a very dark appearance, whereas the larva of the imported species, when full fed, is

reddish pink, the coloring being very slightly obscured by the spines. Furthermore, there are structural differences which enable one readily to separate the two larvæ irrespective of the difference in color.

The important feature, however, is the fact that the Asiatic ladybird feeds on the San Jose scale naturally and normally. Our species, while it is often found in scale-infested orchards in the East, does not feed and multiply on the San Jose scale in a manner to be of any special service. For example, in the grounds of the Department of Agriculture is a little orchard of pear trees thickly infested with the

FIG. 2.—Asiatic ladybird (*Chilocorus similis*), oviposition and early larval stages; *a*, beetle in act of thrusting egg beneath scale; *b*, scale slightly raised, showing edge of egg beneath; *c*, scale lifted from bark, showing manner of attachment of egg to the inner surface; *d*, view of egg in the scale; *e*, egg magnified to show sculpturing; *f*, three eggs placed under flap of bark; *g*, same, natural size; *h*, *i*, dorsal and lateral views of newly hatched larva; *j*, larva, first stage, feeding on mature and young scales—all enlarged except *g*. (Original.)

San Jose scale, the orchard in which an effort is being made to establish the Asiatic ladybird, and yet all the time during the spring and summer of 1902 that this orchard has been under constant observation, but two beetles of our native species have appeared in it, and but two of its larvæ have been seen on the trees. Yet, within a stone's throw of this orchard is a tree infested with a native scale insect (*Aspidiotus ancylus*), and on this tree the *Chilocorus bivulnerus* established itself in considerable numbers. To further test the availability of our native species as an enemy of the San Jose scale, a lot of some 26

adults were collected from the tree just referred to and caged on a San Jose scale infested pear tree. To our surprise, all of these beetles perished without furnishing either eggs or larvæ, notwithstanding that they had absolutely the same conditions under which the imported species was multiplying at a most gratifying rate.

It is evident that in the East our native ladybird has not yet accustomed itself to the San Jose scale nor to the recently introduced *Diaspis pentagona*. In the course of years it may acquire the habit of feeding on these introduced scale pests, but it certainly does not do so at present in a manner to be of very great assistance in keeping

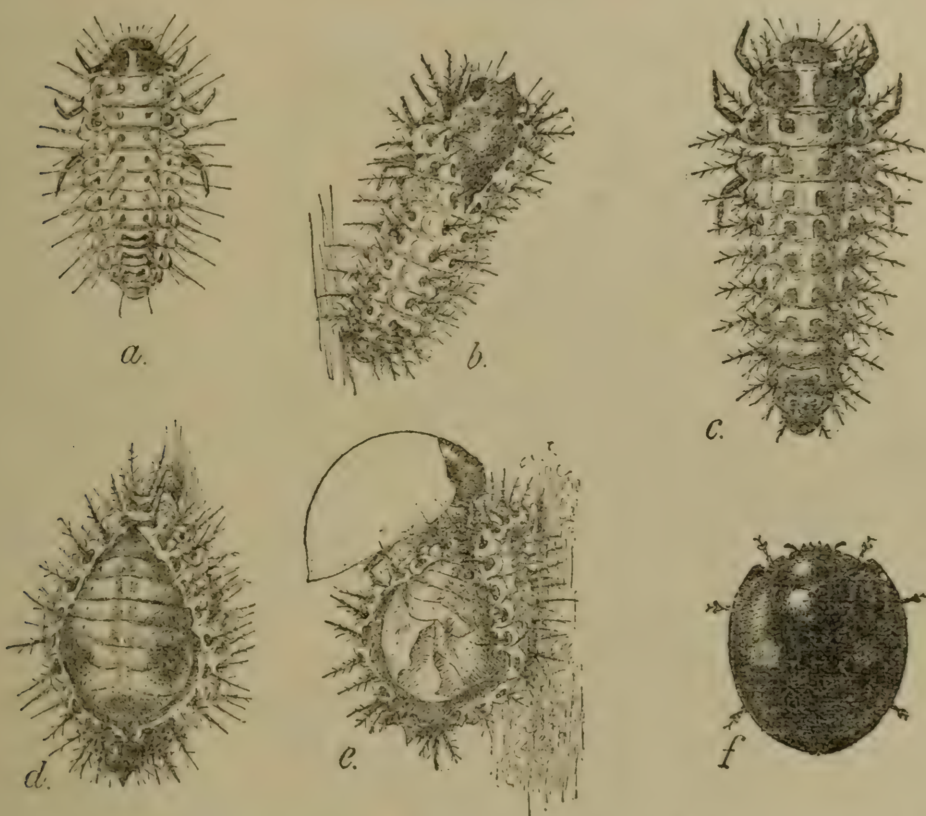


FIG. 3.—Asiatic ladybird (*Chilocorus similis*), later larval stages, pupa, and adult insect: *a*, second larval stage; *b*, cast skin of same; *c*, full-grown larva; *d*, method of pupation, the pupa being retained in split larval skin, *e*, newly emerged adult not yet colored; *f*, fully colored and perfect adult—all enlarged to the same scale. (Original.)

them in check. On the contrary, in California, it is very abundant, and has there acquired apparently the habit of feeding on the San Jose scale, and in both California and Florida it is of very great assistance also in keeping in check the various scale pests of citrus trees.

INTRODUCTION OF ASIATIC LADYBIRD AN EXPERIMENT.

Whether this newly imported enemy of the San Jose scale will really prove an efficient means of controlling this pest in America will require several years for demonstration. The San Jose scale is undoubtedly its normal and natural food. The ladybird multiplies rapidly, and its

larva destroys an enormous number of young scale larvæ in a day. While actively feeding it eats five or six scale a minute, and even if it averaged but one a minute, this would be a total of 1,440 scale insects destroyed per day. Its appetite seems never to be satisfied, and it is eating practically all the time. The adult also feeds actively on the scale insects.

The main question to be decided is whether this Asiatic ladybird can be successfully established in this country, and also whether our native predaceous insects will allow it to yield the full benefit which it should give in keeping the San Jose scale in check. Several predaceous insects were found to prey on the larvæ of this imported beetle, and certain parasitic enemies have also attacked it. All these are agencies which may prevent the full realization of the hopes aroused by this importation. No extravagant claims are being made for this ladybird. The whole matter is still an experiment, but one which we believe to be well worth actively following up. That this ladybird or any other parasitic or predaceous insect will ever completely subdue the San Jose scale in the United States is very problematical, and there is very little doubt but that in the future, as in the past, to free an orchard from this scale pest, it will often be necessary to take the direct and active means now being employed, such as the use of oil or the lime-sulphur-salt wash, or other remedies which experience shall demonstrate to be effective. What may be expected of parasites or predaceous insects is to keep this scale insect in check so that it will not be so generally abundant and destructive, and especially to keep it down in the thousands of small orchards and gardens where direct spraying operations would not often be undertaken by the owners. In particular districts the ladybird may practically exterminate the San Jose scale for one or several years, but at the best we only hope that it will do what it does in China and Japan, namely, keep the scale in such complete subjection that it will not be a more serious pest than our native scale insects, which are rarely if ever very troublesome.

In the matter of climate, it may be said that the regions in which the ladybird occurred in China and Japan duplicate nearly enough all the different climatic conditions in the United States where the San Jose scale is established, so that from this point of view there seems to be no reason why the Asiastic insect should not do well. Its range in Japan and China is as great as from Maine to Florida, and includes every variety of climatic condition.

THE CONTAMINATION OF PUBLIC WATER SUPPLIES BY ALGÆ.

By George T. Moore,

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Introduction.

The widespread interest which has been aroused throughout the country within the last ten years with regard to the securing of sanitary water for drinking purposes is one evidence of the importance of the problem, and no effort is now considered too great or too costly that will insure to the public a constantly pure and wholesome supply of this most necessary article. For a long while the solution of this question was left entirely to the engineer, and he determined not only how the water was to be obtained and distributed, but also, in a large measure, what the quality should be. Too often this latter consideration received little or no attention, and topographical or financial conditions controlled a decision in favor of a reservoir which afterwards proved to be unfit for use, if not absolutely dangerous. Later the chemist was called in, and while people now knew just the amount of mineral and organic matter contained in the water, and certain deductions could be made showing that this might have come from sources likely to produce pollution, there was still no getting at the actual cause of a great deal of contamination; the question of the interpretation of the facts left so wide a field for discussion that in many instances an entirely incorrect idea was given as to the condition of the water.

Indeed, so unsatisfactory have been the results obtained by ordinary chemical methods that one of the most noted chemists has recently said:

> It would seem, therefore, that we are face to face with the question, Is water analysis a failure? It has been so exclusively the province of chemical analysts to pronounce judgment upon domestic waters, and they generally have given so little attention to the large issues attached to analysis and so very much to sets of standard figures for chlorin, nitrogen, hardness, and so on, that the attack from the medical-health side is not unexpected. There has been more wrangling over water analysis than over anything else in chemistry—and for what? Some figures in the second or third place of decimals, probably, and in regard to what this ammonia or that ammonia implies, when a visit to the source of the water and an inspection of the sewage trickling into it might settle everything.

To illustrate this point: The London Commission on Metropolitan Water Supply received evidence that waters containing very large

amounts of organic matter were drunk continuously, with perfect impunity, while other waters, containing so little organic matter as almost to defy detection, had proved, time after time, to be of the most poisonous character. In this country the results of numerous chemical analyses of the various supplies in the vicinity of Boston have shown repeatedly that samples of unpolluted surface water yielded more albuminoid ammonia than a surface water known to be polluted by sewage, and more than once the analysis of the water from a reservoir which had never caused any trouble showed exactly the same percentage of albuminoid ammonia as the water from the foulest supply. Such results as these have led a good many to turn to other sources, in addition to chemical analysis, for information on the subject.

It seems quite as necessary to know the origin and condition of organic matter found in water as to measure the exact quantity and quality of it; and for this reason, of late years, the advisability of a direct microscopical examination has been much advocated. The advantages of such an examination are obvious, and its importance and necessity are fast becoming recognized both by specialists and the public at large.

It should not be understood that in any way has the question of the determination of the purity of water passed from the chemist to the biologist. No one needs the information obtained by the analysis more than he who makes the microscopical examination. The only difficulty comes when one or the other method is considered as the absolute test for purity or pollution, and thus the chemist or biologist becomes the sole arbiter between safety and disease. This cause has often resulted in obvious failures, and hence leading authorities are inclined to question many of the results obtained.

Aside from the assistance obtained from a bacteriological examination in the determination of sewage contamination and the consequent presence of disease germs, the microscope is also of the greatest service to the chemist in explaining his analysis on other grounds. Just as the geological situation will often account for a large and suspicious percentage of chlorin, so the growth of some microscopic organism is frequently the cause of a high figure in albuminoid ammonia or the rapid decrease in nitrates. There are numerous cases on record where water supplies have been condemned on purely chemical evidence, which afterwards have been proved to be perfectly pure hygienically.

When it comes to what have been termed the "æsthetic qualities" of a water—the turbidity, tastes, odors, etc.—there is practically no way of gaining information as to the cause of these except by means of the microscope. As will be shown, the most of the specific odors and tastes in a water are due to the growth of some minute plant or animal within it, and until we are able to definitely point out the cause of

these disagreeable qualities, an analysis of the water is of little avail. These effects, together with those producing turbidity and color, are always looked upon with suspicion by the public, for there is nothing to which a community is so sensitive as something in its water supply which is repugnant to the sense of smell or sight or taste.

The history of the microscopical study of water in connection with its wholesomeness is one which extends over a comparatively short time. While it is true that as early as 1878 a list of 61 places in the United States was published by the health authorities of New York City where water supplies were polluted by certain forms of vegetation, no recommendation for anticipating or preventing such contamination could be given, and it is only recently that any especial attention has been paid to this subject. Consequently, the information we possess along this line is limited, and we are are but little more than at the beginning of where we hope to be before many years have passed. Some progress has been made, however, in determining the specific cause of many of the most evident and disagreeable effects in drinking water, and it is this aspect of the subject which the writer desires to emphasize.

FLOWERING PLANTS IN RESERVOIRS.

The plants most apt to attract attention, which are commonly found in the sources of water supplies, are those usually termed weeds, and generally consist of eel grass (*vallisneria*), pickerel weed (*pontederia*), water plantains (*alisma*), etc. These all have a definite stem, with roots and leaves, and usually produce flowers. In addition to such forms, there is another quite common flowering plant, known as "duckmeat" or Lemna, which is frequently found floating in immense quantities upon the surface of the water. But these flowering plants, either large or small, are not the ones which are responsible for the odors and tastes in water. While they may cause trouble in a mechanical way because of their abundance, or, indirectly, even produce contamination, since they furnish a resting place for obnoxious forms, still, of themselves, they are harmless, and produce no direct effect upon drinking water. It is conceivable, of course, that a sufficient quantity of such plants, if allowed to decay, might produce some unpleasant tastes or odor, but this is a condition which seldom takes place, and, if it does, it is a comparatively easy matter to remove such pollution from the water.

ALGÆ IN RESERVOIRS.

Dismissing, then, the great amount of aquatic vegetation which can easily be recognized as belonging to the flowering plants, there still remains one group, much neglected and frequently unknown, which, because it has seemed to possess no economic importance, has been left to the botanist exclusively. These plants, the algæ, too little known to

possess a common name, are responsible for practically all the bad odors and tastes in drinking water, and, exclusive of the bacteria, are about the only organisms that need to be taken into account in studying the biology of any water supply.

The algæ are a group of plants which number about one-fifth of all the known cryptogams, or flowerless plants, and are almost invariably found in water or in very damp places. It is among these aquatic forms that botanists locate the ancestors of the entire vegetable kingdom, and from a morphological and physiological standpoint they are among the most interesting members of that kingdom. Here we find the largest plants known in nature, at least so far as length is concerned, a Pacific coast form being unquestionably 700 to 800 feet in length, while others have been reported from 1,200 to 1,500 feet long. The algæ also include the largest single-celled plants at present recognized, which often extend for several feet without a distinct cross wall in the tubular forms, and are as large as a golf ball in those of isodiametric shape. The marine species are familiar as the brown kelps and wracks so common along the northern coast, as well as the smaller, more delicate red forms which have been so popular in the adornment of Christmas cards, calendars, etc. In fresh water the algæ are usually grass-green in color, and this hue is so constant that it has given the name to a division of these plants—the Chlorophyceæ. Certain of these green algæ are frequently observed forming a thick spongy layer on the surface of stagnant pools, and are popularly known as "frog spawn" or "pond scum."

SPIROGYRA IN CRESS BEDS.

One of the above forms, *Spirogyra* (Pl. XVIII, fig. 2), is often the cause of considerable trouble in a mechanical way, and on account of its method of forming resting spores (Pl. XVIII, fig. 3) is usually able to withstand the most unfavorable conditions to which it may be subjected in a pond or reservoir. In at least one instance this alga has been the cause of the loss of thousands of dollars by the damage it produced in smothering out the young water-cress plants in the artificial beds constructed for the winter propagation of this vegetable. When the cress is cut for market, it necessarily leaves the plants in a weakened condition, and if the *Spirogyra* gets a start it will form a thick, heavy mat over the surface of the water, which is sufficient to prevent the growth, if not entirely to kill, the cress plants.

BLUE-GREEN ALGÆ.

It is not these easily discerned algæ, however, which are usually the cause of the pollution of water. While they may, like the flowering plants, produce considerable damage and trouble in a mechanical way,

and it is generally the desire of the engineer to keep them out of his reservoir, they are probably a benefit rather than a detriment so long as they are in an active, healthy condition. It has been found that volatile fatty acids, such as butyric and valerianic acids, together with glucose, leucin, tyrosin, and even urea, when properly diluted, can be assimilated by such plants, and no doubt a considerable number of organic substances which are carried into rivers and ponds by drains are destroyed by the larger green algæ. The late Professor Pettenkofer, the eminent German authority in hygiene, was inclined to ascribe the so-called self-purification power of a stream entirely to the action of these plants. There are certain other algæ having the same bright grass-green color as *Spirogyra*, such as *Chlamydomonas* (Pl. XVIII, fig. 4), which are responsible for the odors and tastes in water supplies, but the group of plants which is perhaps best known as polluting drinking water is the one containing the forms popularly called the "blue-green algæ," or Schizophyceæ. The common name denotes that these plants are of a blue-green color, but this is not universally true, for they may assume various shades of olive, yellow, and brown, even appearing chocolate or purplish-red at times. The blue-green appearance is brought about by a combination of leaf-green, or chlorophyll, and another coloring matter of a nitrogenous or proteid nature known as phycocyanin, and this may be variously disguised by the presence of other substances.

STRUCTURE.

Structurally, the Schizophyceæ are very simple indeed. Many of them consist of but a single cell, and multiply by merely dividing and giving rise to two cells like the parent. Others are composed of a series or chain of cells which are held together by a gelatinous envelope, or there may be direct protoplasmic communication between the cells. The contents, however, vary but little with the external appearance of the forms. While the cells are filled with protoplasm and have the usual granules, vacuoles, etc., it is perhaps doubtful whether there is a true nucleus. The coloring matter, instead of being confined to definite bodies, as in the true algæ, is distributed throughout the cell contents, or forms a sheath lining the wall of the cell.

MULTIPLICATION.

In addition to the simple method of division, certain groups of these plants have the power of forming thick-walled spores, and it is by means of these cells that they are able to tide themselves over adverse conditions which it would be impossible for their vegetable cells to withstand. Thus it is that a form which has once existed in a pond or stream may disappear for several years, and then suddenly make its

appearance, because the spores formed by the plants in the first place, having remained in the mud at the bottom, reach maturity, and the combination of temperature, nutrition, etc., is suitable for germination. The conditions most favorable for the rapid increase of the blue-green forms are shallow, stagnant water and relatively high temperature. Consequently, it is during the summer months that the most trouble and annoyance are experienced from these forms, particularly if the water becomes so shallow that the pond begins to dry up and the death of the organisms takes place. Then an easily recognized "pig-pen" odor is given off, and the water is rendered quite unfit for use. It has been shown that this effect is the result of the breaking down of highly organized compounds of sulphur and phosphorus in the presence of the large amount of nitrogen which these plants contain.

NATURAL EFFECTS ON WATER.

In addition to what may be regarded as decomposition effects, some of the blue-greens possess a natural odor and taste, due to the presence of an oil, which upon being liberated produces a most disagreeable result. When very strong, the odor has been likened to raw green corn or to nasturtiums, but usually it can not be likened to anything so pleasant.

The key following will serve to give some idea of the variety of structure within this group, and, together with Pl. XIX, may help in the identification of some of the most obnoxious forms. *Clathrocystis* (fig. 1) is a good example of one of the colony producing blue-greens, and is a very common pest in many reservoirs during the summer months. *Anabæna* (fig. 2) is one of the Schizophyceæ which possesses both spores and peculiar dead cells called heterocysts, and it is one of the most prolific producers of a polluting oil that is known. The third blue-green illustrated, *Oscillatoria* (fig. 3), is characterized by having neither spores nor heterocysts. It is likewise the cause of a most unpleasant odor and taste during the summer.

Key to blue-green algæ.

SCHIZOPHYCEÆ.

(*A*) Plants consisting of a single cell, occasionally united into colonies by being embedded in a gelatinous matrix .... I. Coccogoneæ.

(*B*) Plants having always more than one cell, forming simple or branched filaments, which may or may not be inclosed in an outer gelatinous layer or sheath .... II. Hormogoneæ.

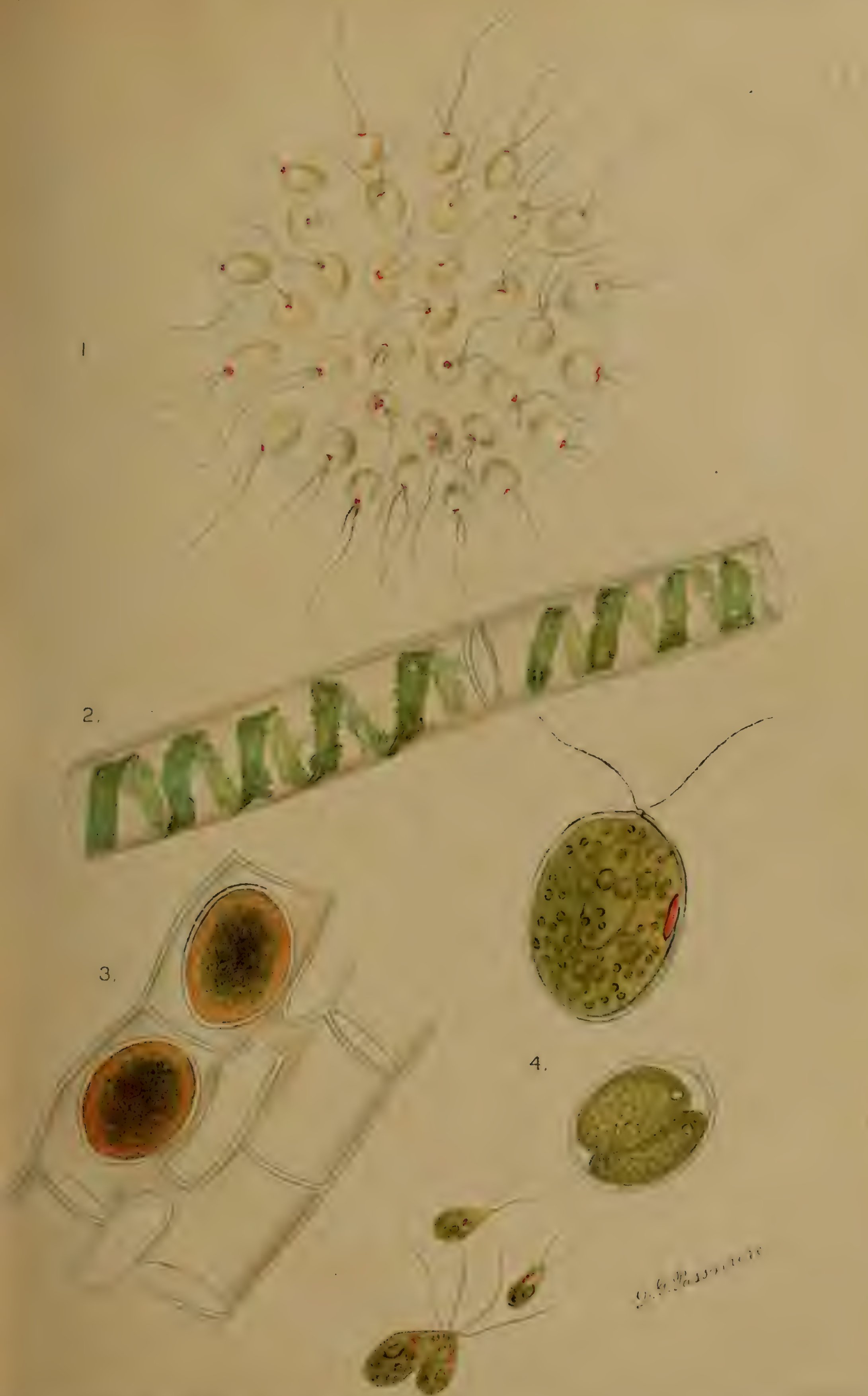
(I) Coccogoneæ:

(1) Cells free or only slightly held together, not forming a definite colony .... *Chroococcus.*

(2) Cells held together in a gelatinous matrix and forming colonies of regular outline.

(*a*) Colonies at first solid, several rows of cells thick, becoming saccate and perforated .... *Clathrocystis.*

(*b*) Colonies hollow, cells only an outer surface ..... *Cœlosphærium.*



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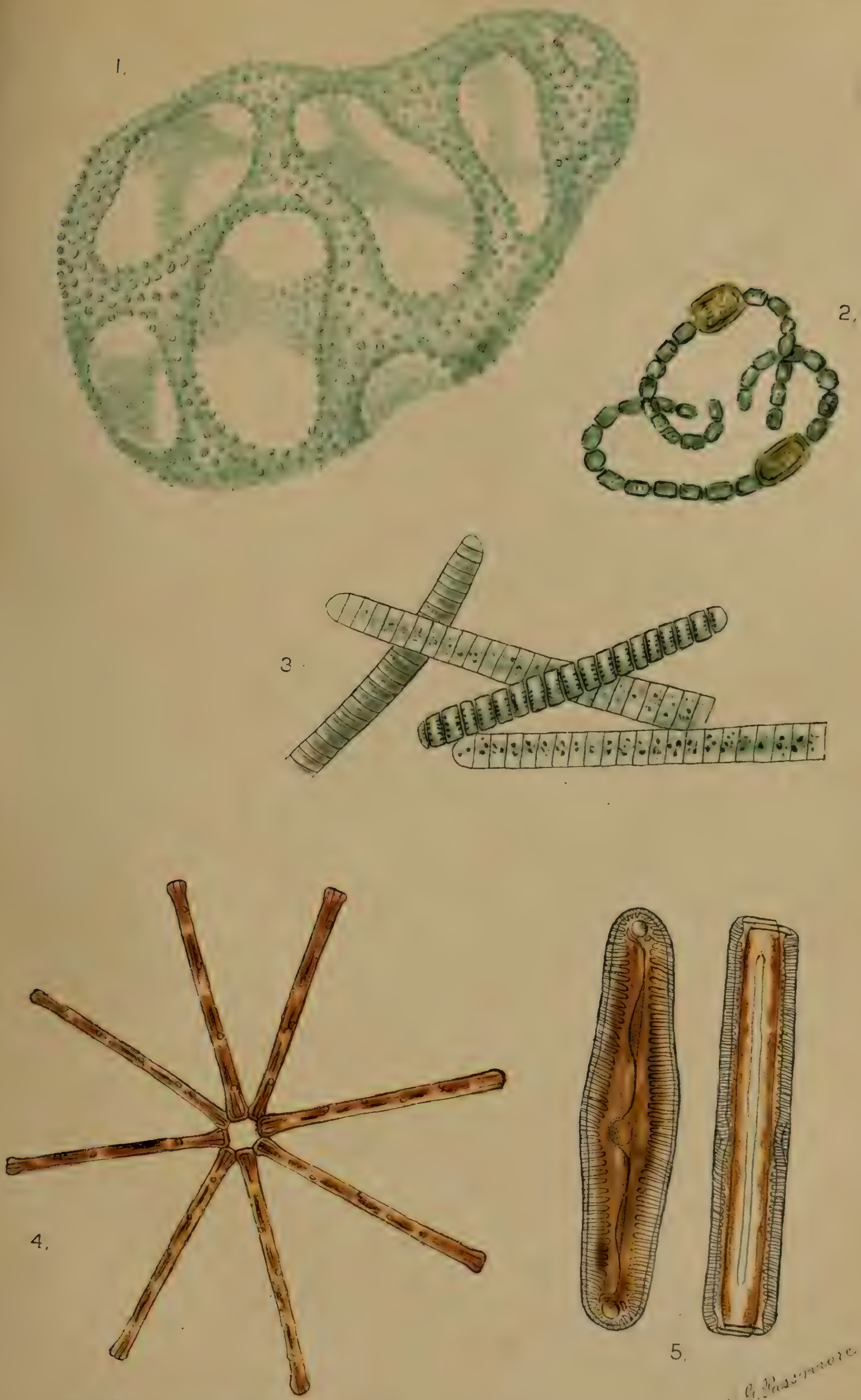
AE: 1, UROGLENA—X 300; 2, SPIROGYRA—X 500; 3, RESTING SPORES OF SPIROGYRA—X 500;
4, CHLAMYDOMONAS SHOWING RESTING CONDITION AND REPRODUCTIVE BODIES—X 1000.

PLATE XIX.



ALGAE: 1, CLATHROCYSTIS – X 500; 2, ANABAENA – X 500; 3, OSCILLATORIA – X 500; 4, ASTERIONELLA – X 500; 5, NAVICULA SHOWING STRUCTURE OF DIATOM – X 500.

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(II) Hormogoneæ:

(1) Cells generally differentiated into three kinds: (1) Vegetable cells; (2) spores; and, (3) heterocysts. The latter usually are of different color, clearer contents, and with thickenings in the walls adjoining the vegetative cells or spores....................(*a*) Heterocysteæ.

(2) Cells in each filament undifferentiated. No heterocysts. (*b*) Homocysteæ.

(*a*) Heterocysteæ:

+ Filaments irregularly interwoven and contorted, inclosed in a definite gelatinous mass ....*Nostoc.*

++ Filaments free or but slightly united.

Ø Heterocysts and spores intercalary.

* Filaments free or united in formless mass ..*Anabæna.*

** Filaments densely agglutinated in fascicles, often of considerable size ....*Aphanizomenon.*

ØØ Heterocysts and terminal spores contiguous. *Cylindrospermum.*

(*b*) Homocysteæ:

+ Filaments simple, with an evident sheath ....*Lyngbya.*

++ Filaments simple, sheath wanting or very slight, plants possessing a characteristic movement ....*Oscillatoria.*

DIATOMACEÆ.

Another great group of algæ which of late years has proved to be of importance in the consideration of the biology of drinking water is that known as the Diatomaceæ (Pl. XIX, figs. 4 and 5). By some botanists these forms are believed to be closely related to the desmids, a family of the grass-green algæ, which seem to resemble them in certain points of morphology and reproduction. On the other hand, there are those who maintain that the diatoms are a special class, being much older than the desmids, and that the points of resemblance are only analogous, not homologous, it therefore being impossible to regard them as proofs of genetic relationship. Whatever their affinity with other algæ may be, they certainly constitute the largest group of any of the aquatic plants (either marine or fresh water), there having been more species of diatoms described than all of the red, brown, and green algæ taken together. It is probable that a great many of these are not true species, but even after making full allowance for such duplication there still remains an enormous number of separate and distinct forms.

STRUCTURE.

In structure a diatom is not unlike a minute glass box, for it is made up of two halves, one fitting tightly within the other, and having its walls strongly silicified. It is this silica which makes the diatomaceous earth valuable for polishing powders. Of at least one article on the market—a tooth powder—diatom shells form a considerable part. Earth containing the remnants of diatoms is also used extensively in the manufacture of dynamite, and the living marine forms constitute an important part of the food of some fishes.

MULTIPLICATION.

These plants have a peculiar method of vegetative multiplication which is unlike anything found elsewhere among the algæ. The two halves of the "box," which are called valves, begin to separate slightly from each other, and as the contents divide into two parts there is formed within two new halves, one fitting into the larger half of the original cell and the other forming a new box within the smaller half of the parent plant. These then separate, and thus there are formed two diatoms of exactly the same construction as the mother cell, although one is a trifle smaller than the other. In addition to this method of propagating the species, there are various ways by which the plant forms a single large resting spore; and recently it has been discovered (chiefly through the work of Castracane and Murray) that it is probable that the whole contents of a diatom cell may break up into a number of small spores, each one of which develops into a new plant.

EFFECT OF DIATOMS.

There are only a few species which are known to give rise to serious trouble in water supplies, but these occur quite frequently and in great quantities. Sometimes the infected water has an odor, variously described as resembling fish or geraniums, and the taste is disagreeable enough to render it quite unfit for use. This condition is often produced by *Asterionella* (Pl. XIX, fig. 4). In addition to this effect, however, diatoms are extremely troublesome when contained in water to be used for the manufacture of paper or for laundry purposes, because of the greenish-brown coloring matter they contain, which stains articles coming in contact with it. Whipple has observed that the growth of diatoms seems to depend upon certain definite conditions of the water—that is, they do not develop when the bottom of the pond or reservoir is quiet; but in spring and fall, when the rising or lowering temperature causes the water to circulate and a good supply of air and nitrates is obtained, the growth is most luxuriant. Thus, it is seen that temperature is only an indirect cause, and not one that need be taken into account by itself.

SYNGENETICEÆ.

There is still another class of organisms to be considered, which is so nearly on the border line between the plant and animal kingdom that it has been placed first in one and then in the other. It makes no particular difference what its precise systematic position is, since these organisms are studied alike by both botanist and zoologist, and one probably has as good a right to claim them as the other. Botanically, the group is known as the Syngeneticeæ. While all the forms may produce more or less pollution, there is one member of this class, *Uroglena*, which demands especial attention, since it is probably responsible for more trouble in water supplies than almost any other organism, either plant or animal.

UROGLENA.

The form known as *Uroglena* is frequently found in New England, and has been reported as far west as Indiana. The probabilities are that it is widely distributed in this country, but has not yet been recognized in many localities. In appearance *Uroglena* resembles a colorless sphere with numerous small greenish cells embedded in its periphery (Pl. XVIII, fig. 1). The whole colony may become a half millimeter (0.02 inch) in diameter, although it is usually much smaller. The individual cells are each provided with a pair of cilia of unequal length, and it is by the vibration of these that the colony is revolved through the water. Each cell of the colony contains a nucleus, a red spot and a single greenish-color body, besides several vacuoles. In addition, there is a considerable number of oil globules, and it is the liberation of this oil which causes the fishy, oily taste and odor produced by *Uroglena*. Among the other algæ the contamination may frequently be brought about by decay, but in this case the trouble is always produced through the mechanical breaking up of the colony and the consequent liberation of the oil contained within the cells. Usually the pumping or gravity necessary to distribute the water is sufficient to free the oil, for the cells are very fragile. In one instance, where the water was used almost continuously for several days for washing caterpillars off the trees, a marked increase in the disagreeable odor and taste was the result. The exact nature of this oil is not very well understood. It is believed, however, to be similar to the essential oils, being nonvolatile at the temperature of boiling water, and seeming to resemble the oils obtained from diatoms and the blue-green forms.

MULTIPLICATION.

No sexual method of reproduction has as yet been observed in *Uroglena*, but it has a rather peculiar method of cell division, which enables it to multiply rapidly. Before a cell divides, it turns in the periphery of the hollow gelatinous sphere, until it is in a position at right angles to the one usually occupied. Then at the end of the cell which originally pointed toward the center of the sphere there are formed a pair of cilia like those at the opposite pole, and a red spot appears. The cell then begins to be sharply constricted, and as it gradually divides the two halves are drawn back through an angle of 45°, so that when the new cells are finally formed they occupy a position similar to the one normally held by the mother cell. When a colony becomes too large, it breaks up into individual cells, and these soon, by repeated division, grow into new spheres. In addition to this way of multiplying, resting spores are formed, which enable the organism to survive conditions which would otherwise exterminate it. In this country *Uroglena* seems to thrive best in cold temperatures, it usually occurring in greatest numbers when the water is frozen over. Just the reverse is true in Europe, where it is most abundant during

July and August, and disappears entirely at the approach of cold weather. For a number of reasons it seems probable that the European form is quite a different species from the one which causes so much trouble in America.

SYNURA AND SYNCRYPTA.

There are others of the Syngeneticeæ which contaminate water, although not to the extent that *Uroglena* does. *Synura* and *Syncrypta* are both known to have a bad effect, *Synura* being responsible for the "ripe cucumber" odor which was formerly thought to be caused by fresh-water sponges. It is probable that these two forms are really the same thing, and Dr. Kirchner, in a note to Hansgirg, has said that he united the two under *Synura*, as he did not consider that a true generic difference existed between them. The somewhat uncertain *Uvella* should perhaps be mentioned here. This form, which greatly resembles *Synura*, has been reported as being one to be most dreaded, causing an exceedingly disagreeable taste that is almost acid. Whether this organism really has this effect has been questioned, but it ought to be watched for and further investigations made.

While there yet remains a considerable number of water-polluting plants which might be described, those already discussed represent all the groups of algæ likely to produce contamination, and the presence of the actual forms figured on Pls. XVIII and XIX would suffice to create a disagreeable water supply from one year's end to another. The aquatic plants often follow each other in rapid succession, and they have their seasons for appearance and disappearance much the same as do flowering plants.

PREVENTIVES OF POLLUTION BY ALGÆ.

COVERING RESERVOIRS.

Up to the present time only the most general methods have been resorted to to prevent the growth of these algæ in water supplies. Since most of them require light for their development, it has been accepted as a law that all reservoirs containing ground or filtered water should be covered. Waters of this character are filled with nutrient salts favorable to the growth of polluting forms, and only require the proper amount of sunlight and air to produce algæ in great quantities. It can not be too strongly emphasized that water is often more subject to algal pollution after its filtration than before, and that unless some provision can be made for excluding the light from the storage reservoir such contamination is very likely to take place. However, the expense and inconvenience of constructing a permanent cover for most reservoirs is almost prohibitive, and there are very few water companies in this country which have made an effort to exclude algæ by this means.

ORGANIC MATTER.

Another precaution which is almost universally practiced is in endeavoring to keep the source of supply and the reservoir as free from organic matter as possible. Frequent inspections of the water-shed are also made to discover any contaminating source, and by this means the complete pollution of the entire supply may sometimes be prevented. Just how far the removal of earth containing organic matter is justifiable in the construction of a reservoir is not yet settled. One water board in this country has thought it worth while to spend $4,000,000 for this purpose alone; but whether the water in this immense reservoir will continue permanently free from algæ remains to be seen. There can be no doubt, however, that anything calculated to prevent the stored water from becoming richer in organic matter of one kind or another is a step in the right direction, and will probably have as much to do with the prevention of pollution as any other one precaution.

AËRATION.

Still a third method of preventing contamination by algæ and one that has been much used in former years is that of pumping air into the water or aërating it by means of fountains or some sort of spraying apparatus. This process is of some value in removing any foul gases which may be in solution, and it thus may have a beneficial effect on the taste and odor of the water, but it is quite certain that its effect upon algæ has been much overestimated. As a matter of fact, some of the unicellular forms are able to multiply themselves very much faster with a plentiful supply of air than would be possible without it, and very often the use of aëration methods in a reservoir may do more harm than good.

NEW METHODS.

Within the last year the Department of Agriculture has inaugurated some experiments which promise to furnish still another means of combating pollution in water caused by algæ. The method as devised in the laboratory of Plant Physiology has already proved to be eminently practicable and successful in exterminating the *Spirogyra* pest in the water-cress beds previously referred to. Since the presence of the water cress in the water somewhat complicates the situation and makes it more difficult, if anything, to keep out algal pollutions, it is hoped that within a very short time it will be possible to apply similar methods in water supplies, and thus successfully prevent the growth of any of the contaminating algæ in reservoirs. The work is still, however, in an experimental stage. When something definite is accomplished the results will be made public.

CONCLUSION.

The importance and necessity of some method of extermination can not be overestimated. There is nothing which so arouses the fear and indignation of the public as a suspicious odor or taste in their drinking water. Bacteria may be tolerated indefinitely, for it is only after there has been an alarming increase in the death rate that any evidence of their presence is made manifest to the consumer. With the algæ, however, a very few days are sufficient in which to make themselves known, and the resulting odors and tastes are so suggestive of dead and dying things that the average individual who drinks the water is easily convinced that he is poisoned. A particularly lurid newspaper account of the trouble, with pictures of "the animals," is all that is necessary to complete the panic. As a matter of fact, none of the products of these algæ is known to be especially deleterious to health. The real amount of organic matter contained in a glass of water rendered unfit for drinking by the algal oil is almost infinitesimal, and unless the plant possessed an actual poison it would be hard to see how it could have any bad effect. Cases are on record where cattle have been supposed to be poisoned by drinking water contaminated by blue greens, but there seems to be reason for doubting the accuracy of these observations. Polluted waters of this kind may aggravate certain diseases of children and probably cause trouble in some intestinal disorders, but, so far as we know at present, none of the algæ is poisonous. When we remember, however, that the disagreeable odor and taste are such as to render the water practically as unfit for domestic use as if it were poisoned, the fact that it is not is but small comfort.

Thus, although there is not now known any positive remedy for the disagreeable effects produced by algæ in water, it is certain that there is much more interest aroused along this line than ever before, and we should expect rapid advances in the future. Since water is so necessary, it seems incredible that we should neglect any means that would help to keep it pure. The time has certainly come when those in authority can no longer afford to neglect the warnings and advice of chemists, bacteriologists, and biologists in regard to the management of the water supplies of this country. Water boards and boards of health are, many of them, doing their utmost, and laboratories are rapidly being established which are giving exclusive attention to problems concerning pure and wholesome water. Already the information furnished by them is being put to a most practical use, and it does not seem too much to hope that in the near future we may be able to dispose of these contaminators of water as readily as of other nuisances which have been abated when science sought the cause and found the cure.

WET AND DRY SEASONS IN CALIFORNIA.

By Alexander G. McAdie,

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INTRODUCTION.

In no portion of the habitable globe, perhaps, are the seasonal conditions more closely watched and appreciated than in California. In no section of the United States are the results of departure from normal condition of rainfall more pronounced. Nature writes in letters large the history of each year's rainfall. Given rain within the seasonal limits, well distributed in frequency and intensity, and a good year is naturally anticipated. Conversely, deficient rainfall or heavy rain not well distributed results in poor harvests. It must be remembered that the rainy season of the Pacific coast is not at all similar to the rainy seasons of the Atlantic coast or of other portions of the United States. From the middle of May until the middle of November comparatively little rain falls, and few atmospheric disturbances pass eastward over the central and southern portions of the Pacific coast from May until November. Our charts of pressure distribution show that during this period an area of permanent high pressure overlies the North Pacific Ocean, resulting in an air circulation unfavorable for rain-bearing winds on the Pacific coast. On the other hand, during the so-called winter months an area of permanent low pressure overlies the North Pacific, resulting in an air circulation such that southeast, south, and southwest winds prevail. During this period numerous atmospheric disturbances are experienced in the North Pacific Ocean, and these, in their eastern passage, cross the coast at any latitude from Sitka to San Francisco, the larger number passing inland north of the forty-fifth parallel. On the coast of California, then, little rain is expected during May, June, July, August, and September. The rain for the year falls practically in the months of November, December, January, February, and March. Showers in April and the early part of May bring the growing crops to fruition. When, therefore, little rain falls during December, January, or February the outlook is poor for the crops in California. Besides agriculture, many other industries of the State are dependent on the supply of water. If it were possible to forecast the character of the rainy season, whether the rainfall would be excessive, normal, or deficient, a great service would be rendered to the farmer, the stock raiser, the

engineer, and the merchant. As an illustration of the relation between harvests and rainfall, Mr. Horace Davis stated that—

> the year 1880 beat the record with a yield of 32,537,360 centals [of wheat], or 1,626,868 tons. * * * This abundant harvest was due largely to the spring rains, unusually

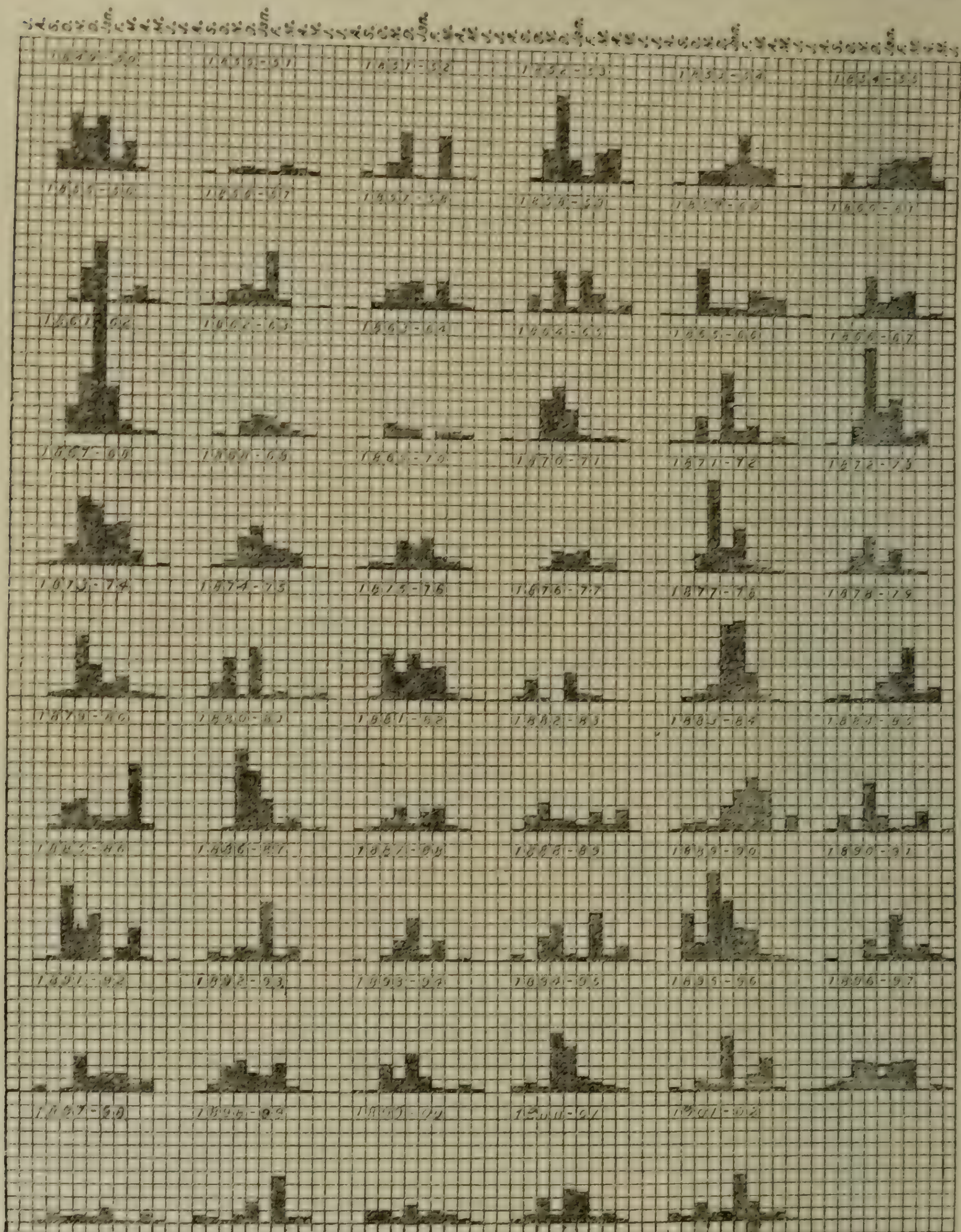

FIG. 4.—Seasonal rainfall at San Francisco, Cal., 1849–1902.

> copious that year. The lightest yields of the decade (1880–1890) were in 1885, 1887, 1888, each after a light rainfall. The crop of 1885, the smallest of all, was 761,739 tons.[a]

Mr. W. F. Fraser, in an article upon "Rainfall and wheat in California,"[b] gives diagrams showing the annual production of wheat for

[a] California Breadstuffs, p. 531. [b] Overland Magazine, June, 1899.

RELIEF MAP OF CALIFORNIA.

[In this map the prominent topographic features of the State are shown—the Sierra Nevada on the eastern border, the Coast Range on the west, and the Great Valley lying between. The map also shows that the western slope of the Sierra Nevada is cut into numerous valleys and canyons, through which flow the tributaries of the principal rivers of California.]

thirty years and the rainfall records (January to April) at Sacramento; and states that the curve of production closely agrees with the curve of spring rainfall, except during three seasons, for which various explanations are given.

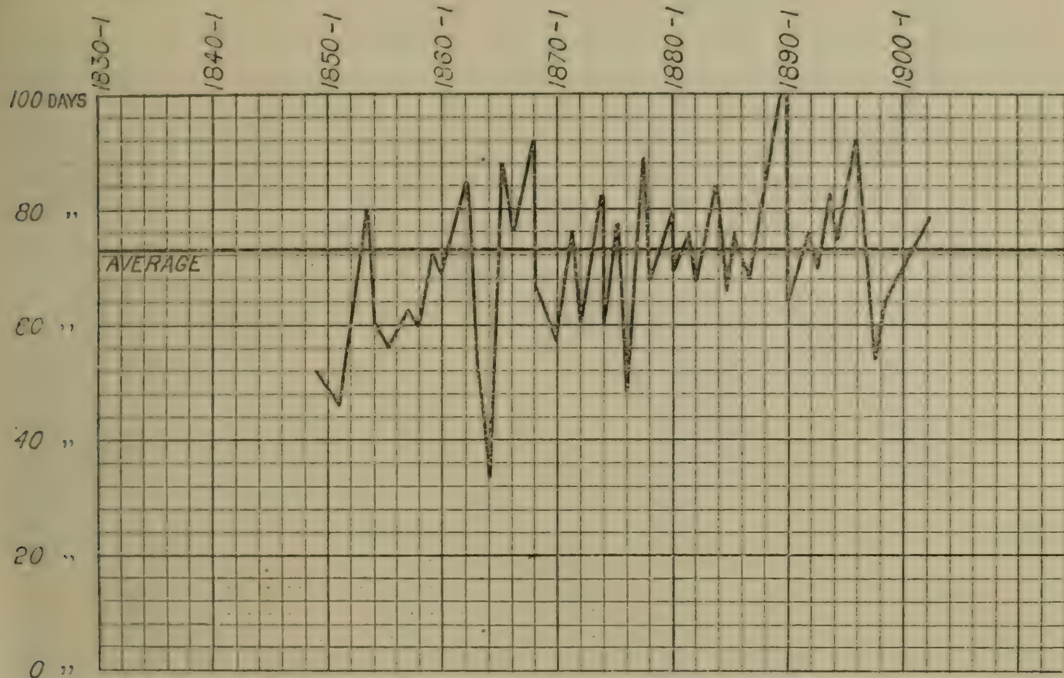

FIG. 5.—Seasonal frequency of rain at San Francisco, Cal., 1849-1902 (normal 71 days).

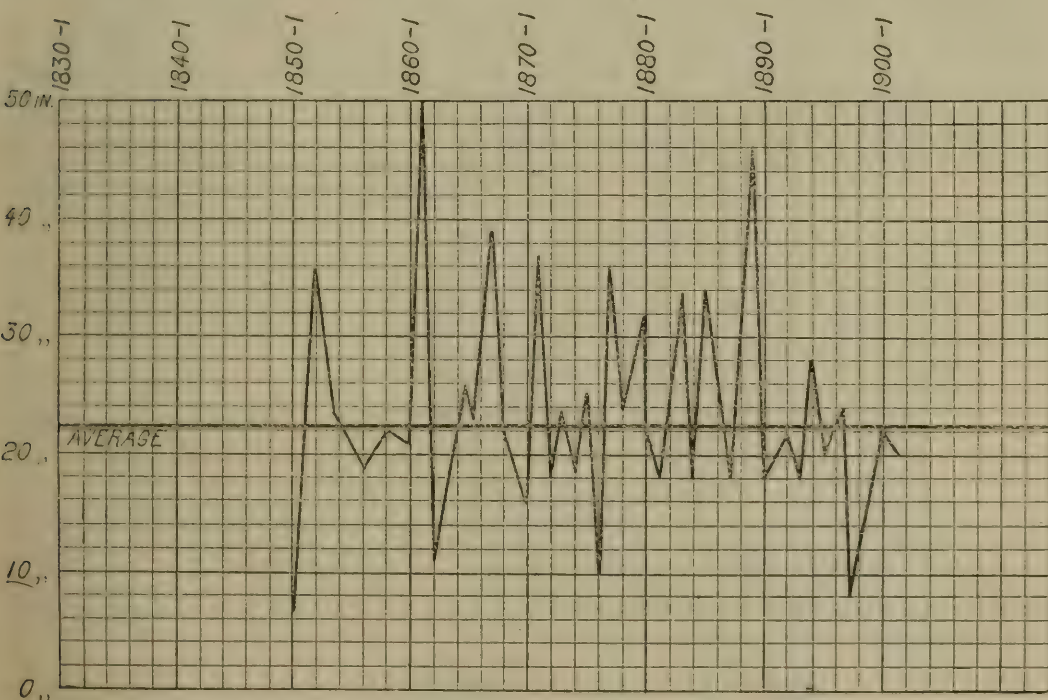

FIG. 6.—Seasonal rainfall at San Francisco, Cal., 1849-1902 (normal 23 inches).

SEASONAL RAINFALL AT SAN FRANCISCO.

In a State as large as California, of which a relief map is given in Pl. XX, it is of course a difficult matter to determine an average rainfall; but in general it may be stated that when heavy and frequent

rains have prevailed in the central portion of the State the season has been of a similar character to the north and to the south. Rainfall records covering a period of fifty years or more are available for San Francisco, San Diego, and Sacramento. The writer has charted the seasonal rainfall both in intensity and frequency at San Francisco for the past fifty-three seasons. (See fig. 4.) The season of 1889-1890 in both respects was an abnormally wet one; the seasons of 1862-1863 and 1863-1864 were abnormally dry. Another abnormally dry season was that of 1897-1898, and indeed the period from 1897 to 1899 was unusually dry. The seasonal rainfall frequency at San Francisco averages 71 days. The seasonal rainfall intensity is 23 inches. (See figs. 5 and 6.)

Seasonal rainfall at San Francisco, 1849-1902.

Season.	Amount.	Days.	Season.	Amount.	Days.
	Inches.			*Inches.*	
1849-50	33.10	51	1876-77	11.04	46
1850-51	7.40	46	1877-78	35.18	88
1851-52	18.44	51	1878-79	24.44	66
1852-53	35.23	69	1879-80	26.66	80
1853-54	23.87	78	1880-81	29.86	72
1854-55	23.68	58	1881-82	16.14	76
1855-56	21.66	53	1882-83	20.12	67
1856-57	19.88	63	1883-84	32.38	83
1857-58	21.81	60	1884-85	18.10	62
1858-59	22.22	66	1885-86	33.05	75
1859-60	22.27	73	1886-87	19.04	69
1860-61	19.00	69	1887-88	16.74	68
1861-62	49.27	81	1888-89	23.86	81
1862-63	13.08	54	1889-90	45.85	108
1863-64	10.08	37	1890-91	17.58	63
1864-65	24.73	67	1891-92	18.53	74
1865-66	22.93	86	1892-93	22.05	67
1866-67	34.92	76	1893-94	18.47	81
1867-68	38.84	88	1894-95	27.29	73
1868-69	21.35	62	1895-96	21.25	91
1869-70	19.31	59	1896-97	23.43	81
1870-71	14.10	56	1897-98	9.38	55
1871-72	30.78	76	1898-99	16.87	65
1872-73	18.02	55	1899-1900	18.47	63
1873-74	23.98	80	1900-1901	21.17	72
1874-75	18.40	60	1901-1902	18.98	78
1875-76	26.01	78			

By reason of its elevation, the catch of the rain gauge on the roof of the Mills Building, San Francisco, is probably 33 per cent below the true catch, and the amounts recorded in the period 1892-1902 are probably in error to that amount.

RAINFALL DURING TWO FEBRUARYS.

Passing from the seasonal rainfalls, it will be more to the point if we compare two periods of equal length, for example, similar months. A season is almost too long a period for detailed study, inasmuch as it frequently happens that one part of the season during which the rainfall is excessive or deficient is offset by another portion of the

season, and thus the true conditions are masked. We are fortunate in being able to compare two winter months; one, February, 1899, which was of a very dry type; and the other, February, 1902, which was of a very wet type. The average precipitation as determined by the records of 299 stations, the records covering for the most part a period of twenty-five years, for the month of February, for the entire State of California, is 2.97 inches. The amount varies from 8 inches in the northern part of the State to less than 2 inches in the southern; and from 4 inches at sea level on the middle west coast to over 7 inches at Summit on the east, at an elevation of over 7,000 feet.

During the dry month the average rainfall for the State was 0.45 of an inch, or an average deficiency of 2.52 inches, equivalent to a deficiency of 28,400 million tons of water. During the wet month there was an excess of 6.17 inches, or about 69,700 million tons of water over and above the amount which would fall in a normal February, approximately 33,600 million tons of water. Between the two extremes of very dry and very wet Februarys there is a difference of approximately 100,000 million tons of water.

RAINFALL AT DIFFERENT LOCALITIES IN CALIFORNIA.

A comparison of the amounts of water at individual localities during these months is of even more significance, for it must be remembered that while the spring rains are of importance in maturing the crops, the bulk of the water supply must fall before the end of February to insure proper germination and early growth. These figures, given in the table following, are also of interest to engineers engaged in the construction of reservoirs, as indicating the amounts of water in very wet and very dry winter months:

Rainfall at various Weather Bureau stations in California for February, 1899 and 1902.

Station.	Elevation of rain gauge above sea level.	February, 1899 (dry).		February, 1902 (wet).	
		Water per acre.	Rainy days.	Water per acre.	Rainy days.
	Feet.	*Tons.*	*Number.*	*Tons.*	*Number.*
Auburn	1,360	19	2	1,437	16
Bakersfield	404	17	1	146	6
Boca	5,531	209	6	283	6
Bodie	8,248	15	2	254	6
Boulder Creek	470	70	4	2,877	18
Eureka	61	568	16	2,202	24
Fresno	293	2	1	275	14
Independence	3,907	0	0	191	3
Laporte	5,000	304	5	3,785	23
Lick Observatory	4,209	85	8	1,064	23
Los Angeles	293	5	3	378	7
Mount Tamalpais	2,375	31	4	1,438	23
Red Bluff	307	1	1	1,374	23
Sacramento	71	5	1	736	19
San Diego	93	34	3	178	8
San Francisco	155	11	2	821	19
San Luis Obispo	201	31	2	993	11

WINTER RAINFALL CONDITIONS AT SAN FRANCISCO.

The following tables show the daily precipitation at San Francisco during the winter months from 1849 to 1902. In the total columns, heavy-faced type indicates wet months; italic type, dry months.

Daily precipitation, in inches, for San Francisco during December, from 1849 to 1901.

[T.=trace.]

Year.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1849			0.45								1.30	0.84	0.15			0.34	0.05
1850	0.08										.26		.35				.36
1851		0.03	.85	0.12	0.23												
1852	.82	.06	.19	.21	.20									0.52	0.03	.20	3.09
1853				.05	.01				0.20	1.35		.11	.02				
1854		.02	.04				0.06										
1855			.10	.07	.17	0.30	1.15			.23			.22	.05	.20		
1856							.15				.28	.21		.04	.03		.45
1857				.15	.20	.26			.22	.43	1.68	.22					
1858				.07	.27					1.80	1.02	.08		.17			.06
1859				.04													
1860	.02					.04	.13			.02	.13	.07		.37	.23	.78	.04
1861	.05		.07			1.02	.29	1.65	.18							.01	
1862									.19								
1863	.33								.15	.05	.02		.27				
1864		.33	.13	.03	.04	.92				.01	1.05	2.56	.99	.04	.27		
1865	.01	.01						.04					.06				
1866	.53		.13								.53	.01			.63	.43	
1867	.02	.18					.15	.55	.24	.33						.04	1.62
1868				.01													.05
1869							.41	1.10		.13	.14						
1870	.59	.57			1.42	.12	.32						.09	.27			
1871		.10															.25
1872				.02													
1873	.03		1.61	.85	1.01	.15	.42	.10	.91				.06	.27	.14	.57	
1874	.06	.05	.05												.02		
1875	.52		.44	.10													
1876																	
1877	.23															.23	.99
1878						.14	.01		.08								
1879	.08	.23	.37		.68		.23	.14	.09	.09							
1880	1.22	1.50	.72	.04	.50			T.	.08					1.81	.36	.26	.43
1881	.27	.02	.18	.87	.60	.02			.15	.03	.31				.52		
1882											.07	.01					
1883		.11															
1884																.10	.60
1885										.29				.05	.02	T.	
1886						.15	.47	.98	.13		T.						
1887	.83	.11	.07	.08			.03	.16	.03	.01		.04					
1888	.03	.02						.03	1.01	.09	.04	T.	1.51	.13	.74	.05	T.
1889	.09	.03	.36	.51	1.44	1.28	.53	1.44	.05	.33	.34	.70					.50
1890			1.83	.18	.02												
1891	.30		.50	.25				.09	.29							.48	
1892	.06	1.22	1.30	.18													
1893	T.												T.	.50			
1894	.03	.18	.02	.56	.60	.23	.83	.87		.23					.10	.01	.21
1895	T.				.09	.11									.13	.02	.13
1896												T.	.28	.02	.07	1.65	T.
1897						T.	.75	.27	.01	T.	.02			.12			
1898													T.	.59			
1899				T.	.05		.03	.11		T.	.11	.04		.91	.46	.09	.11
1900												.03	T.	.41		.70	.10
1901		.34	.20	.08	.23	.05											

Daily precipitation, in inches, for San Francisco during December, from 1849 to 1901—Continued.

[T.=trace.]

Year.	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Total.
1849	0.22	1.21	0.37	0.54					0.41					0.32	6.20
1850															1.05
1851		.28	.11	.06	2.00	0.55	0.60	0.20	.30	0.26	0.24	0.30	0.82	.12	**7.10**
1852	1.40	.05		.21	.07	.76	.11	2.54			.31	1.72	.75	.05	**13.20**
1853		.10	.33		.01	.02					.12				2.32
1854														.75	*.87*
1855		.24	.38	.75	.10				.80	1.09					5.76
1856						.20	.24			.20		.08	.48	1.39	3.75
1857							.98								4.14
1858				.05		.42	.64		.28	1.04	.20			.04	6.14
1859						.21	.63	.38	.21	.10					1.57
1860	.26	.27	.21	.15	.58	1.03	.77	.63	.13	.07				.23	6.16
1861					.03	1.06	.56		2.02	.23	.17	.70	1.25	.25	**9.54**
1862	.12		.05	.32	1.01	.17	.14						.22	.13	2.35
1863				.37		.52	.09								1.80
1864						.38		.47	.81		.02	.04	.30	.52	**8.91**
1865					.04	.15	.25		.02						*.58*
1866	.95	4.28	3.62	.64	.31		.06	.71	.56	32	.63	.40	.42		**15.16**
1867	.69		.48	.84	1.68	.72	.08	1.35				.06	.21	1.45	**10.69**
1868	.55			.07	.18	1.20	.29	.47	.92			.18	.32	.10	4.34
1869					.22	.46	.51	1.34							4.31
1870															3.38
1871	2.83	3.12	.30	.91		2.48	.19		.04	1.05	.40	.82	.17	1.70	**14.36**
1872					.63	.42	1.48	1.39	1.47	.06	.32	.06	.05	.05	5.95
1873	.04	.39			.34						.29	1.16	1.34	.04	**9.72**
1874								.15							*.33*
1875		.38					.06	.83	.19		1.50	.02		.11	4.15
1876															*.00*
1877				.36		.49					.36				2.66
1878												.04	.31		*.58*
1879	.04	1.55	.11	.42	.20						.23				4.46
1880	.25	1.66	.79	T.	.27	.47	.98	.42		.41		.16			**12.33**
1881							.33		.37	.18					3.85
1882	.30	.55	.01		.08		.09				.14			.76	2.01
1883				.28		.15	.17	.12	.01	.07	.01	T.			*.92*
1884	.57	.63	1.62	.28	.48	2.01	.52	.37	.41	.02	.07				**7.68**
1885				2.78	.34	.09	.59	.33	.48				.02		4.99
1886					T.	.14					T.	.16	.04		2.07
1887									.11		.64	.95	.28		3.34
1888			T.	.19	.35	.10	.07	T.	1.09	.11		.24			5.80
1889	.69	1.12	.26	.81	1.24	.09	1.42	.32	.04		.08		.14		**13.81**
1890							.26	.17					.79		3.25
1891		.50				.06			T.	.40	.03	2.21	.40	.11	5.62
1892			.01		.04	.26	1.14	.57	.30	T.					5.08
1893				.97	.04	.01	.43	.01	.23	.06					2.25
1894	.99	1.21	.14	1.19	.16	T.				.30	.39	.37	.02	.37	**9.01**
1895	.01	.33	.27	.34		T.	T.								1.43
1896	.02	T.				.02	T.		.53	.79	.11	T.	.56	.29	4.34
1897								T.							1 22
1898		.70	.32									.01			1.62
1899												T.	.69		2.65
1900			.04	.09											1.37
1901															*.90*

Daily precipitation, in inches, for San Francisco during January, from 1850 to 1902.

[T.=trace.]

Year.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1850	0.25	1.10		0.15		0.05		1.45					0.25	0.60			0.25
1851				.11		.18		.09	0.22								
1852		.07		.03													
1853			0.02	.04	0.69	.01	2.06	.13		0.20	0.33			.18			
1854												0.59	1.22	.27	0.29	0.32	
1855	1.26	.32	.80	.15	.03	.08	.32	.29	.17								
1856								.38	1.05	1.04	.72			.67	.32		
1857		.15	.44	.21	.12											.24	1.19
1858							.03			.25	.37	.40	.51				
1859																	
1860	.08	.07	.24	.21	.56	.22	.23										
1861	.21			1.03	.49	.23									.03		
1862					2.67	1.49		1.35	3.50	2.46	1.25		.22		.49	2.46	2.64
1863	.27		.12	.71	.46						.15						
1864	.12				.39										.14		
1865	.51					.08											
1866					.30	.19	.41	1.51		.40	.46	.60	.60			.23	2.17
1867	.03			.18	.65	.51					.11	.75		.05			
1868	.93	.33	.12	.15				.66			.12	.87	.43			.12	
1869	1.28	.53					.10			.01	.07			.08			
1870										.09	.11	.14	.35	.53	.31		
1871									.42	.32							.21
1872		.01	.71		.19	.08	.05	2.36	.34		.17	.01	.01				
1873	.06	.09	.06		.10			.01			.12						
1874	.89	.77												.05	.38	.39	.79
1875										.01	.04		.07	1.48		.20	
1876	.22	.52	1.47	.13		.20	1.29	.15									
1877																.34	.57
1878						.02	.28	.59		.34			T.	.52	1.94	1.97	T.
1879									.22	.83	.01		.28			.05	
1880							.24	.12	1.03	.03							
1881													.77	.74	.09	.17	
1882		.12	.08	.14	.03	.06											
1883	.57			T.													.03
1884			.16		.48			.04									
1885	.42	.03					.05	.01	.52	.50	.29		.47				
1886												.03	.12	.01	.03		.11
1887												T.	.05		.05		
1888	.79	.32	1.43	.62	.29								.01			T.	.02
1889			T.	.81						T.	.11	.11					T.
1890	.05	.85	.37	.36	.29	.02	.01			.03		.48	.36		.23	1.04	.45
1891	.06	.15	.26	.49	T.									T.	.01		.01
1892	.78			T.			.37	.09									
1893														T.	.27	.05	
1894	.23	.40	.01				T.	T.						.04	1.84	.08	.22
1895			T.	1.96	.15	.06		.82	.01				.45			1.40	.61
1896													.56	.17	.28	.46	.98
1897													.01	T.		.03	
1898						.32	.03	T.			.31	.02			.25	T.	.09
1899	.47	.22	.03			.03	.93		.22	.78	.27	T.	.22	.21	.29	T.	T.
1900	.77	.79	1.56		.18	T.	.62							T.	T.		
1901		.04	.04	1.22	.57	1.75	T.	.07	T.	T.	.54	.15					
1902	T.	.14														T.	

Daily precipitation, in inches, for San Francisco during January, from 1850 to 1902—Continued.

[T.=trace.]

Year.	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Total.
1850......			0.15		0.05	0.58	0.48	0.25	0.53			2.20			8.34
1851......									.12						.72
1852......											0.16		0.32		.58
1853......										0.25	.01				3.92
1854......	0.15				.01	.42	.55	.06							3.88
1855......													.19	0.06	3.67
1856......			.55	0.10	1.14	.47	1.22	1.08					.66		9.40
1857......	.10														2.45
1858......			.83	.55	1.42										4.36
1859......										.05	.21		.17	.85	1.28
1860......					.03										1.61
1861......		0.11	.22			.12									2.47
1862......	.52	.72	1.69	.55	1.00					.04		.76	.55		24.36
1863......		.74	.36		.76	.06									3.63
1864......												.37		.81	1.83
1865......	.07						.07	.83	.38	.74	.91			1.50	5.14
1866......		.11	2.22	1.14	.15	.08	.31								10.88
1867......		.23	.18	.58	.17	.40	.35		.78				.19		5.16
1868......	.41	.43	.64		1.08	.99	.84	.36	1.02						9.50
1869......					.15	1.45	.19	.25	.20	.15	.54	1.10	.25		6.35
1870......	.76	1.03	.27		.30										3.89
1871......	.78				.28	.62					.44				3.07
1872......														.07	4.00
1873......													.12	1.02	1.58
1874......	.04	.82	.02	.08	.01			.31	.03	.11	.62		.24	.11	5.66
1875......	1.87	1.92	.01		.53	1.76	.06	.06							8.01
1876......		.25	.18	.04	.65	1.50	.42	.12	.36	.04				.01	7.55
1877......	.21	.35		.08							.44	.62	1.63	.08	4.32
1878......	.28	.10	T.	.13	1.15	T.	1.68	.02	.13	1.13	.17	.02	.78	.72	11.97
1879......					.04	1.04	.29	.33	.15	T.	.26		.02		3.52
1880......								.16	.47	.06					2.23
1881......		.04	.01						.01		1.18	4.67	.96	.05	8.69
1882......						.40	.22	.06	.33					.21	1.68
1883......							.91	.39				.02			1.92
1884......								.08	.50	.38	.09	1.44	.75	.02	3.94
1885......										.15	.02	.06	.01		2.53
1886......	.44	.85	.96	.28	.52	2.35	.07	.66	.84	.15					7.42
1887......	.62	.76	.80	.19			T.			.03					1.99
1888......		T.	.93	.64	.09	.10	.02	T.	T.	.14		.12	.27	1.02	6.81
1889......	.14		T.	.10		.01									1.28
1890......	.69	.34	.03	.55	.36	.16	.72	1.83				.19	.20		9.61
1891......															.98
1892......							.32	.74	.10				.01	.01	2.42
1893......									.66	.64	.04		1.39		3.05
1894......	.15	.02	2.61	.16	.17							.05	.01		5.99
1895......	.44	.11	T.	.32	.63	.03									6.99
1896......	1.18	.04	1.01	.21		.52		.68	.55	1.35	.15				8.14
1897......			T.				.06	T.		.18	.09	.77	.04	1.08	2.26
1898......		.03			T.		T.	.07						T.	1.12
1899......															3.67
1900......											.01	.18		T.	4.11
1901......			.25	.63	.53			T.							5.79
1902......	.08	.17		.14	.27	.35	.05	.01						.02	1.23

Daily precipitation, in inches, for San Francisco during February, from 1850 to 1902.

[T.=trace.]

Year.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1850	......	......	......	0.45	......	0.15	......	......	......	......	......	......	......	......	......
1851	......	......	......	......	0.02	.11	......	......	......	......	......	......	......	......	......
1852	......	......	......	......	......	.05	......	......	......	......	......	......	......	......	......
1853	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
1854	......	......	......	.22	.51	.16	......	......	0.70	0.52	0.12	1.06	......	......	......
1855	0.09	......	......	......	......	......	0.05	0.24	......	.22	......	......	......	......	......
1856	......	......	......	.03	......	......	......	......	......	......	......	......	......	......	......
1857	......	......	......	.37	.43	......	......	......	......	.07	.05	.31	0.53	1.27	1.30
1858	......	......	......	......	......	......	.03	......	......	......	......	......	.05	.30	.44
1859	.24	......	......	......	......	.16	.08	.54	.11	.12	.62	.78	.14	......	.34
1860	......	......	......	......	......	......	.60	......	......	......	......	.10	.43	......	......
1861	......	......	......	......	......	......	.06	......	.12	.14	2.02	......	......	......	......
1862	......	0.79	......	......	.04	......	......	......	......	......	......	......	......	......	......
1863	......	......	......	......	.44	.16	......	.11	......	......	.16	.71	......	.11	......
1864	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
1865	......	......	......	......	......	......	......	......	......	......	......	......	.30	.10	.08
1866	.36	.16	0.43	.19	.22	......	......	......	.16	......	......	.06	......	......	......
1867	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
1868	......	......	......	......	......	......	......	.06	......	......	......	......	......	......	......
1869	......	.44	.30	......	......	......	.20	.82	.32	1.67	.15	......	......	......	......
1870	......	......	......	......	......	......	......	......	.41	.02	......	.14	......	.11	.34
1871	......	......	......	.37	......	.12	......	.02	......	......	......	......	.14	.13	.67
1872	......	.07	......	.16	......	......	.46	.65	.69	......	.42	......	......	.12	.02
1873	.02	.27	.13	.27	.01	......	......	.64	.23	......	.19	.16	.05	......	.12
1874	......	.30	......	......	......	.01	......	......	.11	.15	.03	.23	.81	.20	......
1875	......	.27	.04	......	......	......	......	......	......	......	......	......	......	......	......
1876	......	......	......	......	......	......	.21	1.80	.21	......	1.35	.01	......	......	......
1877	.33	.01	......	......	......	......	......	......	......	......	......	.52	.10	......	......
1878	......	......	......	.95	T.	.66	.33	.14	......	.02	1.78	.17	.61	1.92	......
1879	......	......	......	......	......	......	......	.10	1.66	.11	.78	.98	.04	......	.51
1880	......	......	......	......	......	......	......	......	.31	.18	......	......	......	......	.14
1881	.01	T.	1.00	.06	.11	......	.29	.08	.01	......	......	.10	.38	......	.28
1882	......	......	......	......	......	......	......	......	.03	.80	.07	.28	.05	......	......
1883	......	......	......	......	......	.13	......	......	......	T.	T.	T.	.40	.51	......
1884	.18	.02	.29	.66	.83	.22	.20	......	......	.01	.01	......	......	.65	1.17
1885	.02	.06	......	......	......	......	......	......	......	......	......	......	......	......	......
1886	......	......	......	......	......	......	T.	......	......	......	......	......	......	......	......
1887	.18	.04	......	2.22	2.92	.01	.24	T.	.12	.28	.50	.79	.36	.55	T.
1888	.05	......	......	......	......	......	......	......	......	.20	.24	.34	T.	.10	......
1889	......	......	......	......	......	.01	......	......	......	......	......	......	......	......	.03
1890	......	......	......	.03	.04	......	......	......	......	......	......	......	......	......	.07
1891	.42	......	......	......	.07	T.	......	......	......	.01	.01	.01	......	.01	3.38
1892	.30	......	......	.34	......	.39	......	......	......	......	......	......	......	......	......
1893	.03	.19	.09	.57	.28	.04	......	.36	1.06	......	......	.13	......	......	......
1894	......	......	......	......	.50	......	.09	.03	.07	.14	.01	T.	......	......	.38
1895	......	......	......	......	......	......	......	......	......	.06	.96	.91	.10	......	......
1896	.18	......	......	......	......	......	......	......	......	......	......	......	......	......	......
1897	1.23	.05	.42	.66	.61	.01	.36	......	......	......	.02	.03	.17	.02	T.
1898	.20	......	.02	......	.08	.17	.19	T.	......	......	......	.12	......	......	......
1899	.08	T.	.02	......	......	......	......	......	......	......	......	......	......	......	......
1900	......	.08	......	.02	......	......	......	......	......	......	......	......	......	T.	......
1901	......	......	.09	.59	.55	T.	.01	.28	......	......	......	......	.09	.08	......
1902	.01	.15	......	.01	.18	T.	.46	.97	.03	......	.23	.02	......	.58	.72

Daily precipitation, in inches, for San Francisco during February, from 1850 to 1902—Continued.

[T.=trace.]

Year.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	Total.
1850....							0.18				0.99				1.77
1851....			0.04		0.12	0.12			0.13						.54
1852....		0.02											0.03	0.04	*.14*
1853....							.29	0.15	.37	0.34	.27				1.42
1854....				0.01	.05	.91	1.10	.25		.56	.48	1.26	.13		**8.04**
1855....							.15	.11		.25	1.29	.52	1.85		4.77
1856....				.12	.33								.02		*.50*
1857....	0.84		.04	.04					.87	1.17	.85	.45			8.59
1858....	.41	.25		.20	.15										1.83
1859....	.14	1.04						.13	.34	.12	.08	1.11	.23		6.32
1860....	.04	.17	.14											.12	1.60
1861....						.21		.08	.10	.99					3.72
1862....				.44		2.09	.80	.84	.33	1.49	.38	.33			**7.53**
1863....	.40	.58	.47		.05										3.19
1864....															*0.00*
1865....	.12		.40	.24								.05	.05		1.34
1866....												.07	.47		2.12
1867....			.49	.15	2.12	2.22	.30			.08	.14	1.02	.68		**7.20**
1868....						.64	.51	.14	.86	.69	1.61	1.02	.37	.20	6.13
1869....															3.90
1870....				.08	.86	.25	.90	1.57	.10						4.78
1871....					.72	1.02	.28	.29							3.76
1872....	.49	.22	.08			.42	.73		1.28	.02	.13	.94			6.90
1873....	.13		.82						.05		.02	.75	.08		3.94
1874....	.08	.28								.01					2.21
1875....										.01					*.32*
1876....									.30	.13		.90	.01		4.92
1877....					.01		.05			.16					1.18
1878....	.42	.92	1.25	.39	.14			.60	.40		1.16	.47	.19		**12.52**
1879....	.04	.66	.02												4.90
1880....			.58	.22		.33	.06	.05							1.87
1881....	1.37									.12	.83	.01			4.65
1882....	.41							.10	.52	.06	.60	.04			2.96
1883....															1.04
1884....	1.29	.78	.23		.11										6.65
1885....			.09	.06	.06	.01									*.30*
1886....								.01		T.	.02	.03	.18		*.24*
1887....	.33				.04	.34			.32						9.24
1888....		.01													.94
1889....	.01		.06					.01	.59	.01					.72
1890....	1.07	.29	.70	1.27	.74	.62	.23		.01	.09					5.16
1891....	.54	.04	.31	.02	T.	.46	.69	.22	.12	.10	.22	.18	.39		**7.26**
1892....		.04	1.03	.71	.05	.01			.03						2.90
1893....															2.75
1894....	.05	.10	.14	.85	.33										2.69
1895....						T.	.19	.09							2.31
1896....						.01					T.	.01	.05	.03	*.28*
1897....	.06	.01	.27	.39	.09								.01		4.41
1898....					T.	.44			.78	.02	.01	.21			2.13
1899....													T.		*.10*
1900....			.02	T.	.50	.01	.01				T.				.64
1901....	T.	.07	.48	.79	.05	T.		1.95							5.03
1902....	T.	.12			.53	1.08	.30	.13	.84	.60	T.	.31			**7.27**

From these records it appears that there is no regular sequence of wet and dry seasons; nor does it follow that a wet winter month necessarily dominates the season, inasmuch as there are instances where wet Decembers have been followed by moderate rainfall, and conversely, Decembers with little rainfall have been followed by wet seasons. As a rule, heavy rainfalls in December are followed by heavy rainfalls in January and February. When, however, we study the distribution through a number of years, it becomes evident that there is a well-marked relation between pressure, wind direction, and rainfall.

Grouping the Januarys into abnormally wet, wet, average, dry, and abnormally dry, we have the following:

January moisture conditions, by years, in California.

Abnormally wet.	Wet.	Average.	Dry.	Abnormally dry.
1850	1865	1853	1857	1851
1856	1867	1854	1859	1852
1862	1869	1855	1860	1864
1866	1874	1858	1861	1873
1868	1888	1863	1880	1882
1875	1894	1870	1885	1883
1876	1901	1871	1892	1887
1878	....	1872	1897	1889
1881	....	1877	....	1891
1886	....	1879	....	1898
1890	....	1884	....	1902
1895	....	1893	....	....
1896	....	1899	....	....
....	....	1900	....	....

Weather Bureau records began at San Francisco in March, 1871, and it is therefore possible to compare the pressure charts of sixteen abnormally wet and abnormally dry Januarys.

During wet years the Continental "high" is considerably weakened and lies rather to the east of the Rocky Mountains, while the North

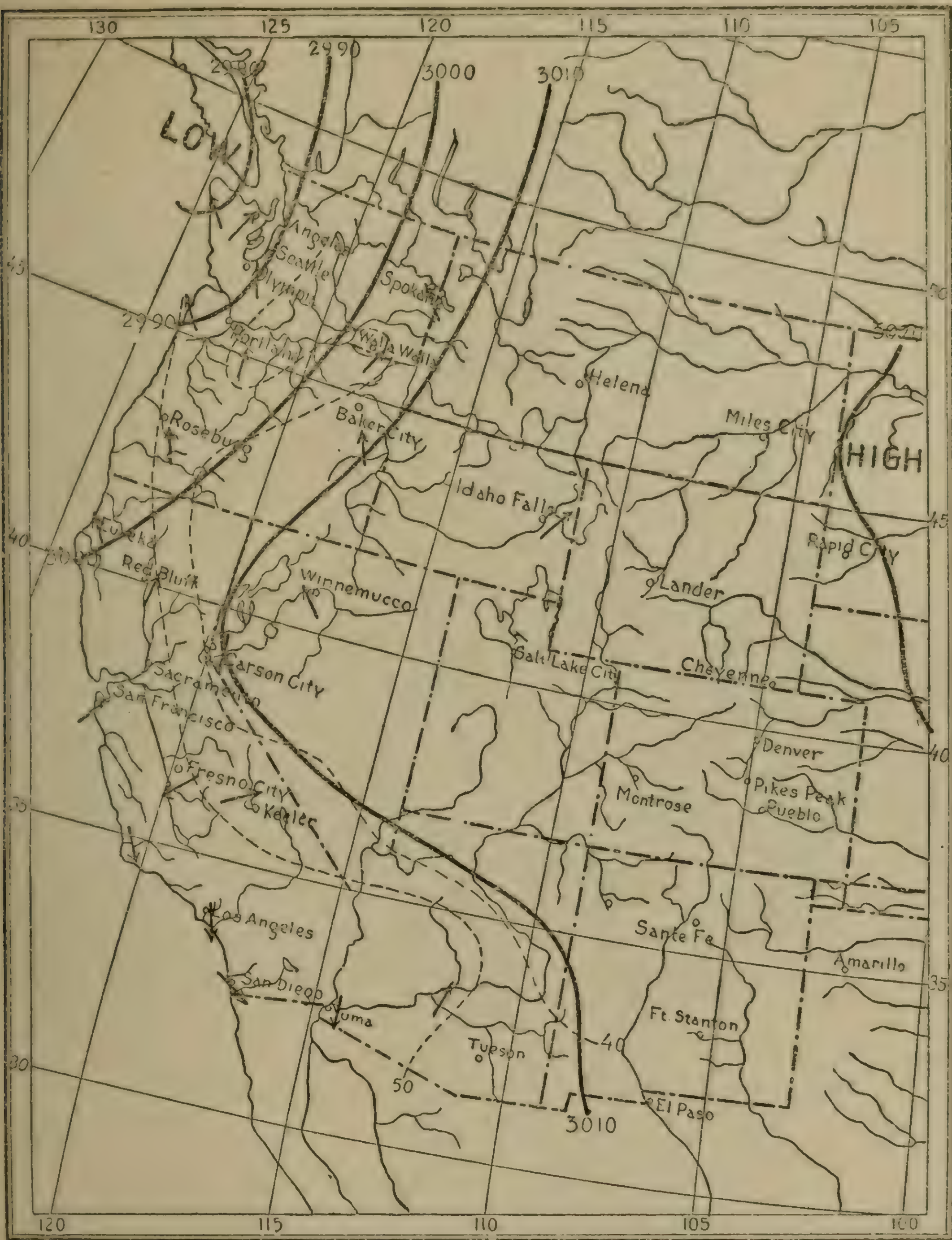

FIG. 7.—Pressure distribution and prevailing winds during a wet January (1896).

Pacific "low" extends well in on the coast overlying western Washington, western Oregon, and western California. A good illustration

is that of January, 1896 (fig. 7), and the same distribution is found in all wet Januarys. During dry years the Continental "high" is

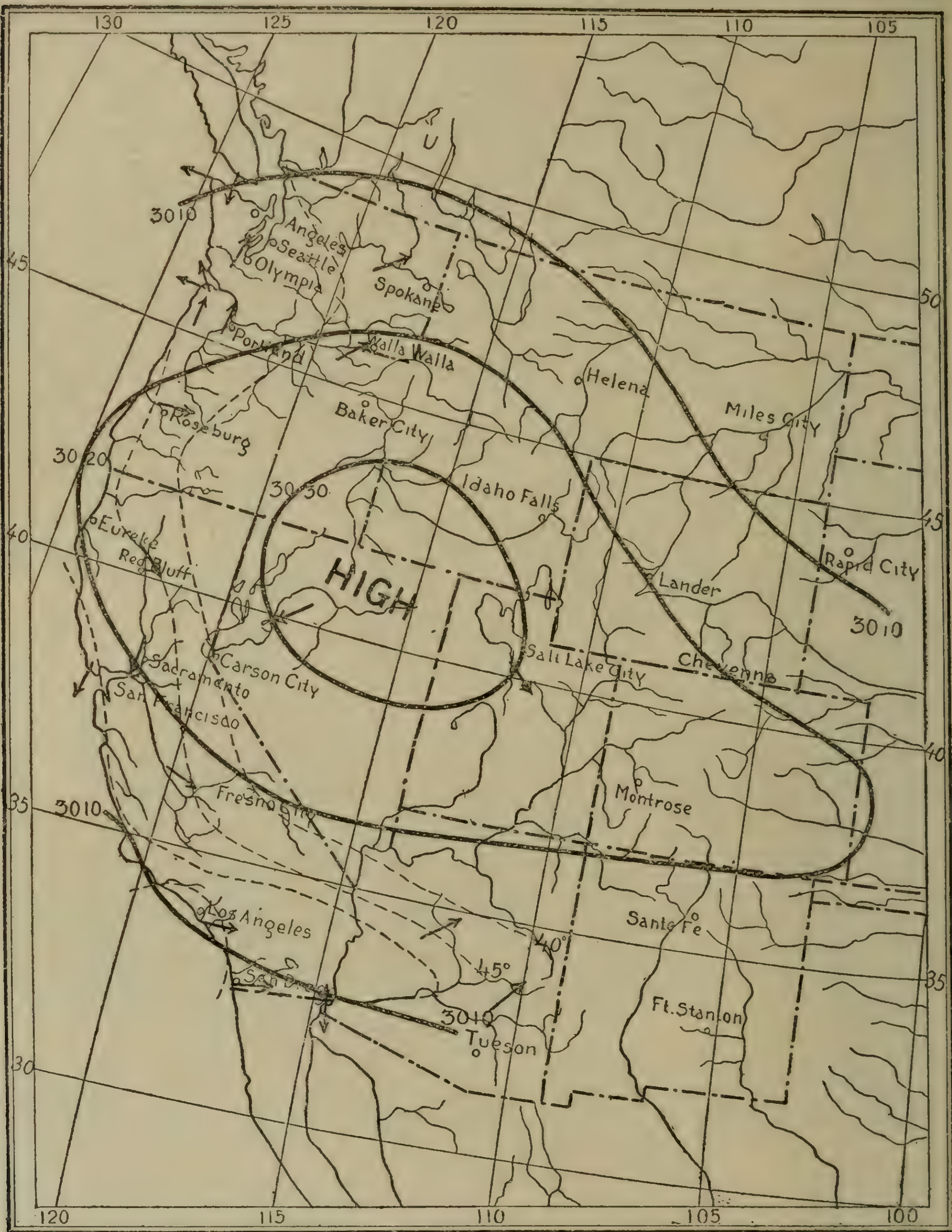

FIG. 8.—Pressure distribution and prevailing winds during a dry January (1891).

well over the Northwest, and the North Pacific "low" does not appear within the United States. An excellent illustration of this is January, 1891 (fig. 8).

Again, grouping the Februarys into abnormally wet, wet, average, dry, and abnormally dry, we have:

February moisture conditions, by years, in California.

Abnormally wet.	Wet.	Average.	Dry.	Abnormally dry.
1854	1855	1861	1850	1851
1857	1859	1863	1853	1852
1862	1868	1869	1858	1856
1867	1872	1871	1860	1864
1878	1884	1873	1865	1875
1887	1890	1876	1866	1885
1891	1901	1879	1874	1886
1902	....	1881	1877	1889
....	....	1897	1880	1896
....	....	....	1882	1899
....	....	....	1883	1900
....	....	....	1888	....
....	....	....	1892	....
....	....	....	1893	....
....	....	....	1894	....
....	....	....	1895	....
....	....	....	1898	....

A somewhat similar relation of pressure to rainfall is found to exist. The conditions during a wet month are shown on the chart for February, 1902, and for a dry February on the chart for 1899 (figs. 9 and 10). It is evident that when the Continental "high" lies well to the northwest the month is a dry one, and, conversely, when the North Pacific "low" overlies the northwestern portion of the country the month is a wet one. If there were any way, then, by which we could forecast the permanent pressure areas we could forecast the air circulation—whether northerly, accompanied with dry weather on the California coast, or southerly and accompanied with wet weather.

Southerly winds of great frequency, high velocity, and extended cross section mean large quantities of moisture carried over the State. The

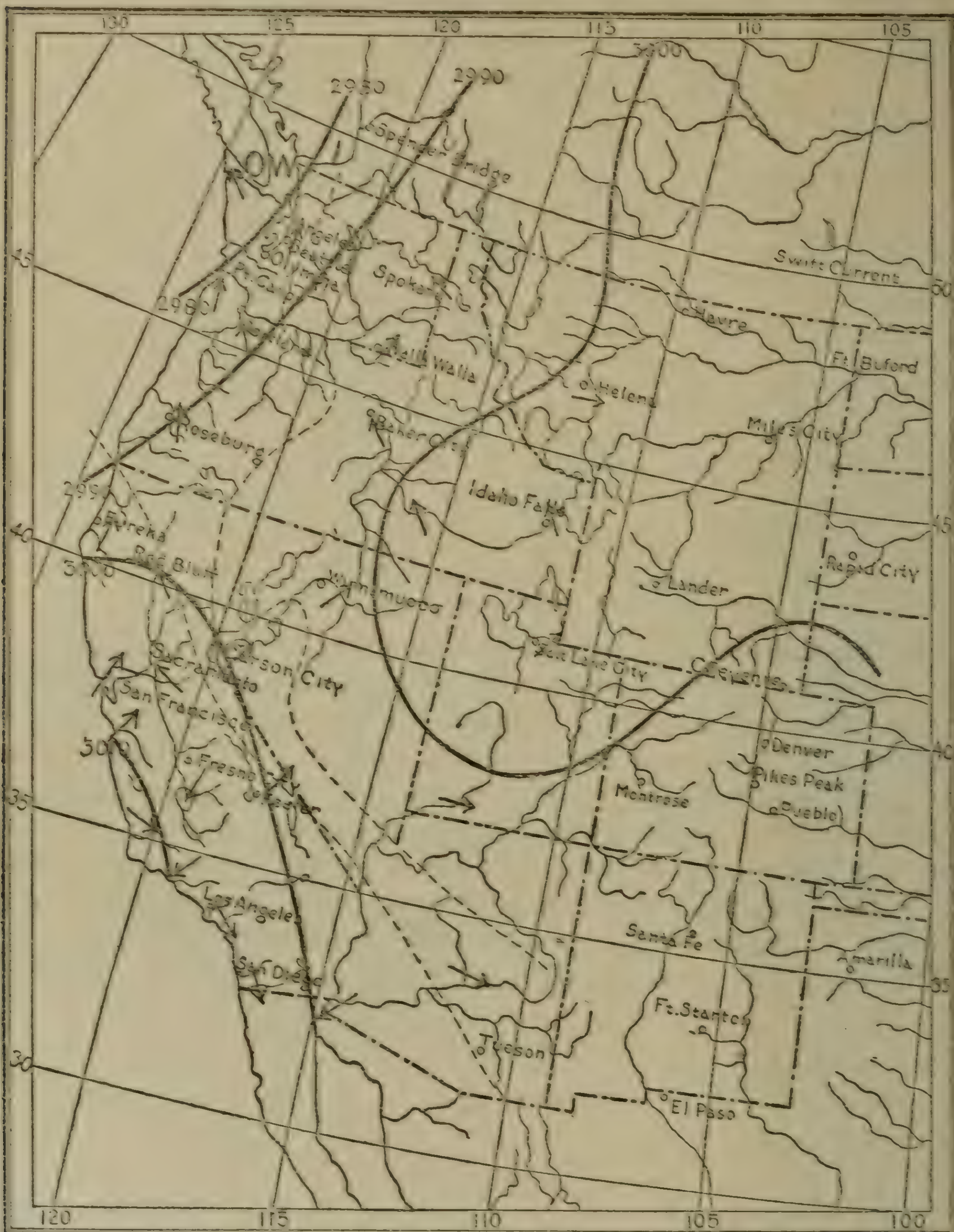

FIG. 9.—Pressure distribution and prevailing winds during a wet February (1902).

exact factors determining condensation and precipitation are not definitely known; but the angles of inclination of the mountain systems

in California to the rain-bearing winds are such that a general uplifting of the air strata must occur, and this would favor precipitation.

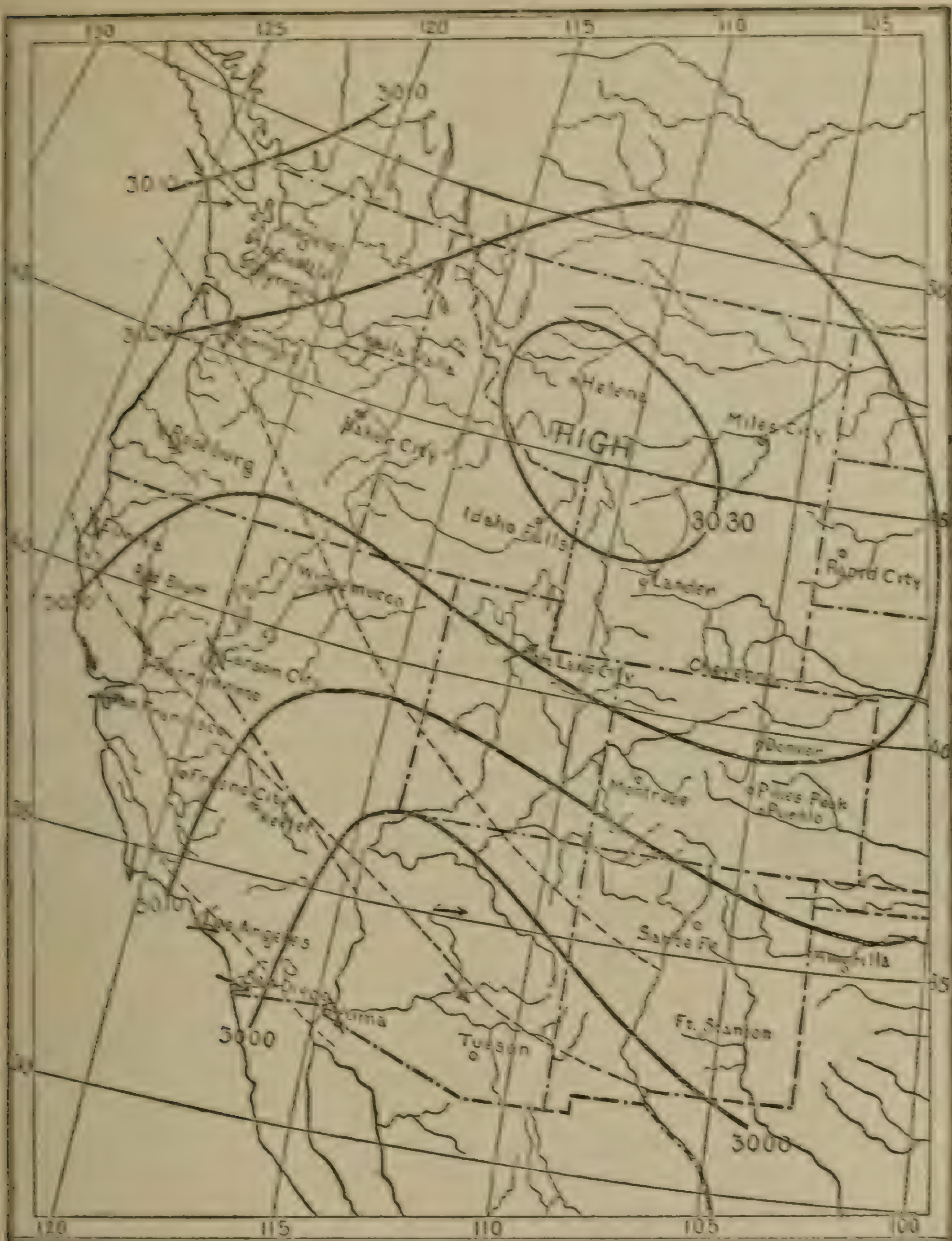

FIG. 10.—Pressure distribution and prevailing winds during a dry February (1899).

Conversely, winds from the north can bring but little moisture, and even that little is not likely to reach very far west of the crest of the Sierras.

CONCLUSION.

California offers exceptionally good opportunities for studies of seasonal variations and climatic abnormalities. While there is not, as in the case of Greece, a classical literature to which one may appeal, as Professor Aeginitis has done, for a comparison of present climatic conditions with those of twenty centuries ago, there is in California a growth of Sequoia which in all probability extends over a period covering thousands of years. In the rings of annual growth we have to some degree a summed-up history of the seasons. Unfortunately, the tree is not a willing witness, and it is not an easy matter to compare the rings of growth with the seasonal rainfall and determine a definite relation between the two; but this much at least seems probable, that there has been no material change in the climate of California during the past three thousand years.

Coming down to the period of recorded history, it is not difficult to identify the climate in the vicinity of San Francisco, as noted near the end of the sixteenth century, with that of to-day. Sir Francis Drake landed on this coast in 1579 and remained for a month and a week on the beach about 35 miles northwest of the city. The description of the winds, the fogs, and the temperature during the period has been carefully studied in connection with the Weather Bureau records for a number of years for the same period, from June 17 to July 24, made within a mile of the spot on which Drake is supposed to have landed. The similarity of the records is too close to be accidental.

The records of the past fifty-three years speak for themselves. There does not appear to be any evidence of a permanent change in climate. Wet and dry seasons come and go with little regularity. A deficiency in rainfall seldom extends over two seasons, and the same is true of excessive rainfall.

AUDUBON SOCIETIES IN RELATION TO THE FARMER.

By Henry Oldys,
Assistant Biologist, Biological Survey.

Audubon societies are organized for the preservation of native birds. They aim to prevent all wanton and reckless decrease of bird life, whether by indiscriminate or excessive shooting of birds for use as food or for the sake of the plumage, by useless or immoderate egg collecting, or by too much trapping for caging; and also to develop an appreciation of the living birds from an æsthetic standpoint. As in the case of all movements of this kind, individual instances of excessive zeal coupled with ill-balanced judgment may be noted here and there, but the object sought to be accomplished is both worthy and necessary, and should receive the support and cooperation of all rational and thoughtful people, particularly farmers, who are, in some respects, the chief beneficiaries of the societies' efforts.

Wanton destruction of natural resources is always inexcusable. The vicious habit of extravagance thus engendered is certain to be harmful, at least in its incidental effects, and to cause economic losses that sooner or later must be deplored. It is highly desirable, also, to avoid as far as possible the destruction or reduction of the raw material, so to speak, from which is derived that growing knowledge of the character and properties of natural objects and forces that is the basis of all practical progress.

VALUE OF BIRDS.

But apart from general reasons against excessive destruction of bird life, it is desirable that such destruction be checked because of the distinctive value of birds to the nation. It is seldom that a proper estimate is placed on the importance of the large, edible birds that are usually known as game birds. They are generally regarded as chiefly useful in that their pursuit and capture furnish a healthful and fascinating sport, and add a little variety to the accustomed fare. But they have a far more notable function than this. With proper restraint and the adoption of systematic measures to maintain the supply, such as are in vogue in some sections of the country, the United States might easily have a stock of game birds so abundant as to furnish a cheap and readily attainable food supply worth many millions of dollars annually. By preventing all immoderate, unnecessary, and unseasonable killing, and by carefully protecting nests,

eggs, and young, the people of this country could add materially to local and National assets. Some of the game birds, too, such as the quail and wild turkey, are very useful destroyers of insects, and are thus doubly valuable. Dr. Sylvester D. Judd, of the Biological Survey, states of the quail that "as an enemy of insect pests and a destroyer of weed seed it has few equals on the farm."[a]

The value of birds as a class to the agriculturist is no longer a matter of speculation, but has reached the point of satisfactory demonstration. Various investigations, particularly those conducted by the Biological Survey, have placed beyond question the importance of the service rendered by birds in keeping down the floods of insects and weeds that assail crops. Without the aid of these natural guardians of garden and orchard the difficulties of successful agriculture would be greatly augmented, if, indeed, they would not become insurmountable. A number of species, it is true, are of little, if any, use to the farmer, and a very few are positively injurious to his interests. But protection is not usually accorded to those species that work injury; and while the preservation of such as are neutral in relation to agriculture is not as important to the farmer as the preservation of those that are instrumental in increasing his profits, yet it is of indirect benefit to him in that the existence and abundance of the less useful birds tend to divert attack from the rest.

Birds also have an æsthetic value that should receive due weight in considering the desirability of their preservation. The inspiration they have offered to poets of all ages and the enjoyment their presence brings to millions who lack capacity or desire to give expression to their pleasurable emotions or sensations have a definite place among nature's contributions to man's happiness. And many who have no positive appreciation of æsthetic enjoyment would become conscious of the loss were such enjoyment withdrawn; just as they would miss the sunshine were the skies to become perennially overcast. A spring ushered in silently and without the stir of active life and bright plumage in tree and field would be so altered in character that the change would be perceptible to the dullest, most indifferent natures. In this way all birds have value, just as all verdure has its charm, though it may be necessary to remove certain plants that are poisonous or interfere with thrifty husbandry.

Thus, as food, as preservers of crops, and as legitimate stimuli to the finer faculties, birds fill a place that is of distinct and definite benefit to man. Their extinction would be an irreparable loss.

DANGER OF EXTINCTION OF BIRDS.

The fundamental reason for the need of active measures protecting our native birds is based on the rapid settlement of the United States,

[a] Bulletin No. 17, Biological Survey, Dept. of Agr., p. 85, 1902.

with the accompanying increase and dispersion of population. One hundred years ago the five or six million people that inhabited this country occupied scattered settlements in the East. To the westward stretched an immense unbroken wilderness with resources so vast as to appear inexhaustible. This great tract seemed a reservoir of limitless supplies, and the only problem that presented itself was how to tap it most conveniently. Animal life was abundant and apparently fully able to replenish itself. No inroads could be made by the isolated and unorganized attacks it might sustain that would cause any but the most transitory diminution. During the first half of the following century little occurred to disturb the idea of the inexhaustibility of nature's bounty. The great West was yet beyond all power of reduction to definite limits, and even in the well-settled East no marked indications of exhaustion were manifest.

But what a change has been wrought by the enormous influences of the past fifty years! The bison, whose countless herds dotted the vast prairies, reduced to a few hundred head, carefully guarded to prevent absolute extinction of the species; the passenger pigeon, whose passing clouds darkened the sun for hours at a time, now rarely seen and practically confined to two or three States near the Great Lakes, where a few small and scattered flocks replace those that formerly numbered myriads; the antelope and the prairie chicken passing away; the elk in serious danger; and various other mammals and birds, such as the moose, caribou, mountain sheep, mountain goat, otter, beaver, ducks and geese, wild turkey, and ruffed grouse, making rapid progress in many localities from abundance to extinction. This has been largely due to the individual work of hunters and sportsmen, but in recent years a new and far more powerful agent has arisen. At the present time a species, no matter how numerous, is at the mercy of the highly organized industrial and commercial system that has superseded the individualistic system of a few decades ago. The wants of the masses are supplied, not by their own individual and necessarily scattered and desultory exertions, but by systematic, specialized, and efficient means. The people, greatly increased in number, have been brought into closer touch with each other, and, in consequence, their tastes have become more uniform. Fashion decrees that aigrettes shall be worn, and in a few years the immense heronries of Florida are exterminated, while the devastating scourge of the plume hunter passes down the coast of Mexico and on into South America as far as the doomed birds are to be found. Where once were acres of snowy plumage, a rare glimpse of a few birds is all that is left. Again, beneath the inexorable mandate of fashion, the tern, or sea swallow, in a few years, is swept from the Atlantic coast; a few isolated, carefully protected colonies the only remnant of what was once one of the most abundant birds of the Eastern seashore. Again, fashion decides that

the wing of the ptarmigan will make an attractive hat decoration, and so thoroughly is its whim gratified that a single shipment from Archangel, Russia, consists of 10 tons of wings.[a] No spot is so remote or difficult of access that the purveyors of fashion will not penetrate it in executing these despotic decrees. Whatever species is selected to be "worn" is doomed to practical extinction; for wild birds are not like poultry and beef, the supply of which can be regulated. As soon as one species becomes extinct, or nearly so, another is marked for destruction.

Other agencies also are at work depleting the ranks of the birds. The trolley is rapidly changing rural to suburban life. While there is a marked tide of humanity from the country to the city, at the same time the city is extending tentacles in every direction far into the outlying districts. As a result of this changed condition many small boys, who are embryo sportsmen and ardent egg collectors, and many cats, most destructive enemies of small birds, are carried readily to hitherto inaccessible districts.

Egg collecting, which is not confined to boys, is a source of great destruction of bird life. Periodicals devoted to oology show how extensive is the practice. An idea of the recklessness with which nests are broken up to satisfy this fad is conveyed by an instance quoted by W. T. Hornaday from the Oologist. A collection of sets of warblers' eggs was advertised in that journal, which comprised 51 species and 1,274 sets, with a total of 5,433 eggs.[b] This, it must be remembered, was the result of the zeal of one collector alone, and represented only a part of his entire collection. In some of the instances of nest robbing, it is probable that other eggs are laid to replace those removed and no decrease in bird life is caused; but in innumerable cases this is prevented and a very serious loss to our avifauna results.

Some degree of destruction of small birds is due to the habit of killing and eating them, which has been brought to this country by certain of our European immigrants. This practice is notably prevalent in Massachusetts, Rhode Island, Pennsylvania, Michigan, and various Southern States. In the fall and winter the markets of New Orleans are stocked with thousands of song birds which have been shot for the table. This is a source of loss that unless checked is sure to grow as the game birds become less. Already robins, meadowlarks, turtle doves, blackbirds, flickers, and even reedbirds (bobolinks) are on the game lists of some States, and where other song or insectivorous birds are not protected, or where public sentiment does not sustain nominal

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[a] "A Russian province of the North," by Alexander Platonovich Engelhardt, governor of the province of Archangel, Philadelphia, 1899. The government's record shows a slaughter of nearly 2,000,000 grouse in four years, 1894–1897, in the one province of Archangel.

[b] "The destruction of our birds and mammals," extracted from the Second Annual report of the New York Zoological Society, p. 16, New York, March 15, 1898.

protection, it would easily be possible for the growing decrease in what are generally recognized as game birds to cause a serious inroad upon the smaller birds to supply the deficiency.

Through these various instrumentalities the birds of the United States would soon go the way of the buffalo and passenger pigeon were there no active interest manifested in their preservation. For it must be remembered that there is no stopping place in the work of destruction, but that on the contrary it is constantly increasing in effectiveness as civilization embraces more people, covers more territory, produces greater unification, and brings a higher degree of mastery over nature; moreover, the rarer the object of demand, the keener its pursuit. It is important, therefore, that Audubon societies should continue their work of bird protection and that they should be supported in this work. And the question of just what these associations are and how they are accomplishing their chosen task is one of more than passing concern to all who are mindful of the best interests of their country.

ACCOUNT OF AUDUBON SOCIETIES.

The first National movement in favor of protection of the nongame birds of the United States was originated in February, 1886, by Dr. George Bird Grinnell, editor of Forest and Stream. An association called "The Audubon Society" was formed on the 13th of that month with headquarters in New York City, but with local secretaries and members scattered throughout the country. Its purpose was "the protection of American birds, not used for food, from destruction for mercantile purposes," and it was called into existence by the sudden onslaught made on American birds to supply the demands of the millinery trade of America and Europe. Its growth was rapid: in three years it had attained a membership of nearly 50,000, drawn from every State and Territory of the United States except Oregon, Idaho, Montana, and Arizona; and from Canada, Mexico, Bermuda, the West Indies, England, France, Germany, Switzerland, Turkey, India, and Japan. It was represented in the periodical world by a publication called The Audubon Magazine, issued monthly by the Forest and Stream Publishing Company. In 1889 the publication of this magazine was discontinued because of lack of support; and as the society seemed to have accomplished the object for which it was established the movement died out.

A subsequent revival of the demand for birds for millinery purposes led to a reawakening of sentiment on the subject, and in January, 1896, a State Audubon Society was organized in Massachusetts. In October of the same year a similar society was established in Pennsylvania. The following year, 1897, brought the organization of State Audubon societies in New York, Illinois, New Hampshire, Wisconsin,

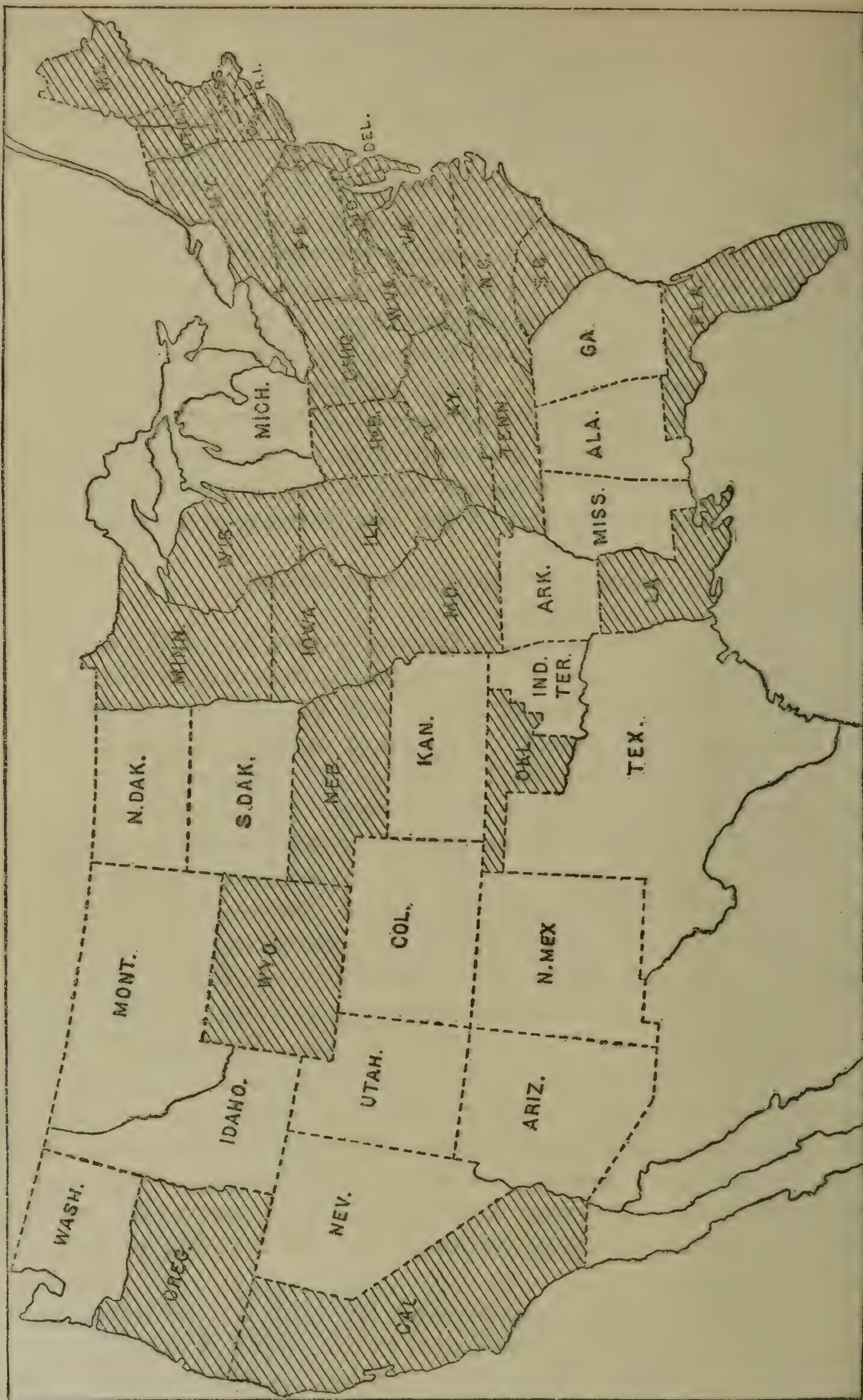

FIG. 11.—States (shaded) that have Audubon societies. The District of Columbia, which does not appear on the map, should be added to the list.

the District of Columbia, New Jersey, Iowa (the Schaller Audubon Society), Minnesota, West Virginia (as a branch of the Pennsylvania society), and Rhode Island. Four more societies were established in 1898; five in 1899; four in 1900; four in 1901; and five in 1902. All of the States east of the Mississippi are now represented except Michigan, Georgia, Alabama, and Mississippi, and nine of the twenty-three States and Territories west of the Mississippi. (See fig. 11.) The total membership is about 65,000. The committee on bird protection of the American Ornithologists' Union has worked in cooperation with both these movements and connected them, as by a slender thread. This committee and the various State associations are all independent organizations, but are brought into close touch with each other through Bird Lore, a bimonthly magazine established in February, 1899, to serve as the organ of the Audubon societies. A still closer understanding has been brought about by the creation, in 1901, of a National committee in which each society is invited to be represented.

METHODS OF AUDUBON SOCIETIES.

The various lines of activity exhibited by Audubon societies divide themselves naturally into two categories: (1) Awakening of public sentiment, and (2) securing adequate legislation and enforcement of the same.

AWAKENING OF PUBLIC SENTIMENT.

The attainment of the first and most important of these lines of action, the awakening of favorable public sentiment regarding bird protection, is sought by means of branch societies or local secretaries, libraries of bird literature, lectures, exhibits of hats with other decorations than wild-bird plumage, work in the schools, distribution of literature, calendars, and bird charts, and spring outings for observation of birds. Each of these methods will receive a brief consideration.

Branch societies or local secretaries.—At least 16 of the State societies have extended the influence of their organizations throughout their respective States by establishing subsocieties or appointing local secretaries at widely scattered points, thus securing little centers of interest from which to spread the principles of bird protection. These auxiliary societies are sometimes organized among school children, as in Wisconsin, which has 787 such local branches, with a membership of 21,108; and sometimes wholly or partly among adults, as in Minnesota, which has about 60, in addition to many school organizations and children's bird clubs.

Libraries.—In this class of bird-protective work two methods have been followed: (1) Sections devoted to bird literature have been established and maintained in some public library by means of Audubon society influence and contributions, and (2) traveling libraries have been instituted. The first of these methods is particularly useful in

large cities where classes in bird study have been formed among the school-teachers. The second, which consists of sending a small collection of books relating to birds from point to point throughout the State, to remain at each place a stated time, is an excellent means of arousing in rural districts interest in birds and their protection. At least ten States have such libraries circulating within their borders; and two of these, Connecticut and Pennsylvania, keep eighteen and twelve libraries, respectively, in circulation.

Lectures.—Lectures, like libraries, may be divided into two categories. Either lecturers are secured to deliver addresses before the society and its friends, or lectures are prepared, with typewritten manuscript and numerous lantern slides, and sent out to different rural points, to be read by some local resident. More than a dozen of these traveling lectures have been prepared and are in frequent use. Connecticut has three and Massachusetts two in constant readiness to meet the numerous demands for them.

Millinery exhibits.—Millinery exhibits, or "hat shows" as they are often called, are arranged by Audubon societies conjointly with local milliners. Hats are submitted by various dealers, each trimmed without using anything objectionable to the principles of the society. To this display the public is invited, the object, of course, being to show how attractive hats and bonnets can be made without involving the destruction of bird life. Ostrich plumes and the feathers of barnyard fowls are the only plumage permitted in these displays. To one, however, who is not familiar with modern methods of treating the feathers of common barnyard fowls such exhibits are a revelation. Five or six States have held these displays at intervals and with excellent results. After one in Philadelphia several of the leading milliners established "Audubon departments" in their shops.

School work.—Great attention is paid by Audubon societies to work in the schools. Not only are small boys very destructive of birds and their eggs, but the boy and the girl represent the future man and woman, and with a well-established acquaintance with birds acquired in youth, there is not apt to be thoughtless destruction of bird life at maturity. Numerous means are employed to arouse the children's interest in the study and observation of birds. Lectures and libraries play their part here as elsewhere. Bird charts are prepared and furnished to the schools by means of which pupils can identify the wild birds observed (see Pl. XXI). Prizes are offered for the best compositions or essays on birds. Outings are arranged for the scholars, which are devoted to observation of the birds. When it is possible the study of birds is added to the curriculum; but this is not often expedient. In many States a "bird day" is established, either by law or by arrangement with teachers. This consists in setting aside one day each year to be devoted to birds. Sometimes a "bird day" is held in combination with "arbor day," when birds

BIRD CHART ISSUED BY THE MASSACHUSETTS AUDUBON SOCIETY.

[Greatly reduced.]

1. Red-headed Woodpecker.
2. Phœbe.
3. Bronzed Grackle.
4. White-bellied Nuthatch.
5. Whip-poor-will.
6. Warbling Vireo.
7. Least Flycatcher.
8. Wood Pewee.
9. Maryland Yellow-throat.
10. Ovenbird.
11. Yellow-throated Vireo.
12. Black-throated Green Warbler.
13. Cardinal.
14. Redstart.
15. Chestnut-sided Warbler.
16. Meadowlark.
17. Rose-breasted Grosbeak.
18. Pine Warbler.
19. Cowbird.
20. Brown Thrasher.
21. Towhee.
22. Tree Swallow.
23. Yellow-billed Cuckoo.
24. Indigo Bunting.
25. Wilson's Thrush.
26. Vesper Sparrow.

JULY

SUNDAY		5	12	19	26
MONDAY		6	13	20	27
TUESDAY		7	14	21	28
WEDNESDAY	1	8	15	22	29
THURSDAY	2	9	16	23	30
FRIDAY	3	10	17	24	31
SATURDAY	4	11	18	25	

AUGUST

SUNDAY		2	9	16	23	30
MONDAY		3	10	17	24	31
TUESDAY		4	11	18	25	
WEDNESDAY		5	12	19	26	
THURSDAY		6	13	20	27	
FRIDAY		7	14	21	28	
SATURDAY	1	8	15	22	29	

Wood Thrush.

GRAY LITH. CO. N.Y.

SPECIMEN PAGE OF CALENDAR FOR 1903.

ISSUED BY THE MASSACHUSETTS AUDUBON SOCIETY.

share attention with trees. Clubs, societies, and orders are established among the children, and pins and badges are distributed. In these and many other ways the various societies seek to excite the interest of the children in the wild birds and their preservation.

The main object of this work is, of course, the beneficial effect upon the children, but it may have value of another kind. A great deal is yet to be learned of the habits of birds. Many details are wanting concerning their movements while nesting, the period of incubation, the time the young are in the nest, the frequency of feeding, and other characteristic habits, and much light can be thrown on these subjects by children trained to observe carefully and accurately. And this fact may be used effectively in furthering school work. To a bright, observant child, the knowledge that a composition, based on actual observation, may be an important contribution to ornithological information is a great incentive to study. Such work as this is especially useful in country schools, for country boys have better opportunity both for destroying birds and, when once their interest has been aroused, for observing and enjoying them.

In addition to the work among the children direct, classes are held and lectures given for the purpose of instructing the teachers, in order that they may be properly fitted to impart correct information to the pupils in their charge. The District of Columbia society has been particularly assiduous in this work, and, in consequence, many of the teachers of Washington are unusually well qualified to teach ornithology to their scholars.

This is a phase of the work that should appeal particularly to the farmer; for birds that are directly employed in keeping down insects and weeds are destroyed in great numbers by schoolboys. Enlisting the interest of the boy in the living birds and their broods is the surest way to make him their friend instead of their enemy, and thus convert him from their destroyer to their protector.

Literature.—An immense amount of literature relating to bird protection has been distributed by the various societies. Brief pamphlets showing the economic value of birds, or the destruction of certain species, or setting forth other facts pertinent to the work of the societies, are scattered broadcast. With these should, perhaps, be included the bird calendars issued by several societies, which contain pictures of various common birds and descriptions of the birds or the months, usually quoted from the works of well-known writers on nature (see Pl. XXII). This is an important feature of the educational work of Audubon societies.

Field meetings.—A few of the societies have instituted regular spring outings, which the general public is invited to attend. Favorable localities are visited and studies of the birds in their haunts are pursued under the direction of experienced ornithologists.

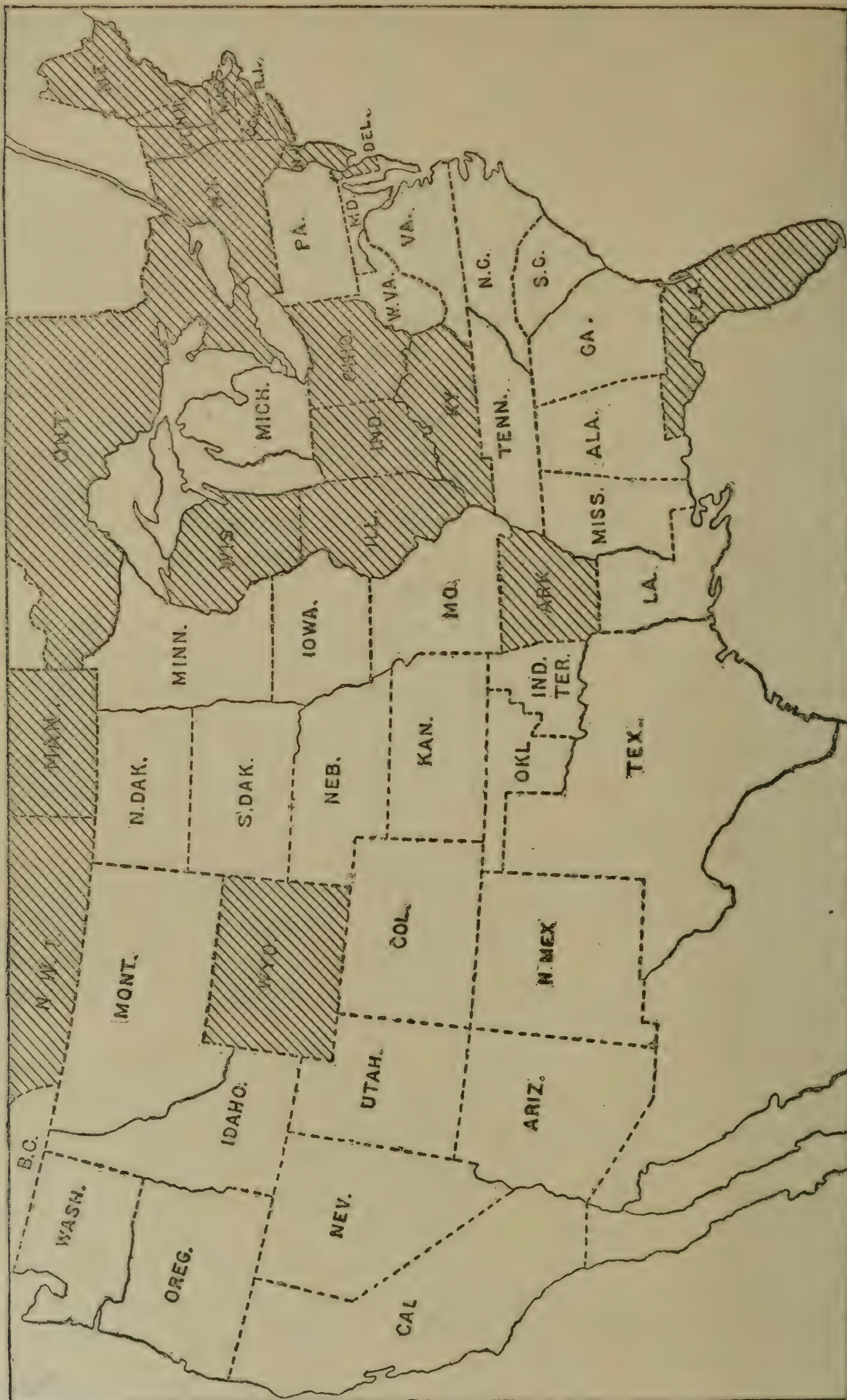

FIG. 12.—States (shaded) that have adopted the model bird-protective law proposed by the American Ornithologists' Union. Alaska and the District of Columbia, which do not appear on the map, should be added to the list.

SECURING AND ENFORCING LEGISLATION.

Educational work is of prime importance and will undoubtedly show increasing results as the years pass. But to secure immediate effects and to reach some that are impervious to milder means it is desirable that laws be passed making reckless or wanton destruction of birds illegal, and that such laws be properly enforced after they have been placed on the statute books. To this end Audubon societies have been actively engaged in securing in their respective States the adoption of suitable laws, usually based on the model law of the American Ornithologists' Union. This law protects practically all nongame birds and their nests and eggs. It is now in force in 18 States and 2 Provinces of Canada (see fig. 12), besides Alaska and the Northwest Territories of Canada, and earnest endeavors to extend its field are made each year.

The protection of game birds is generally left by Audubon societies to the League of American Sportsmen and the numerous other State and National organizations of sportsmen. Even those who deprecate the taking of any life for sport and not from necessity recognize the futility of attempting to abolish this ingrained habit. Hence, inconsistent though it may be, the combination is frequently witnessed of those who wish to preserve birds from unnecessary killing and those who wish to preserve them for unnecessary killing. Copies of the State laws are freely distributed throughout the State by Audubon societies, either in circular form or as posters. And occasionally infractions have been reported to the authorities and active steps taken to secure convictions, in order that the laws may not become dead letters through lack of interest in their enforcement.

RESULTS.

Active and enthusiastic work in a worthy cause can not fail to bring results, and the State Audubon societies, greatly benefited by the labors of the former Audubon Society with its official organ, the Audubon Magazine, and by the hearty cooperation of the bird-protection committee of the American Ornithologists' Union and game-protective organizations, have, during the seven years that have elapsed since they began to spring into existence, accomplished much in furtherance of their object.

The traffic in native birds for millinery purposes has been almost entirely suppressed. Ostrich plumes, the skillfully treated feathers of barnyard fowls, and the skins and plumes of foreign birds now compose all but a small percentage of the bird material used for hat decoration. The first two of these classes of millinery goods do not involve in their use sacrifice of life or decrease of species; the third is very destructive of the bird life of the world, but can not be reached

except by international cooperation. Steps looking to such cooperation have been taken, however, and it is hoped that before long this waste will be checked.

Nearly all the breeding colonies of sea birds on the Eastern coast are now protected. This has been mainly through the efforts of Mr. Abbott H. Thayer, of New Hampshire, with the cooperation of some of the Audubon societies.

Nongame birds have been largely eliminated from the food market.

The trapping and shipment of native birds for use as cage birds has been greatly reduced. As it was conducted, this business was making serious inroads upon certain native species, particularly mockingbirds and cardinals.

A great interest in nature study has been aroused in recent years, largely through the work of Audubon societies, and has exerted a most beneficent influence on the people, particularly the youth of the country. The camera is to some extent superseding the gun, and many are realizing for the first time the interest and pleasure attached to closer contact with nature.

THE FARMER'S INTEREST IN BIRD PROTECTION.

In spite of the active work of thousands of earnest men and women the depletion of bird life continues. How rapid would be the destruction without these efforts it is not difficult to conceive. On the other hand, a much more general interest in bird protection would soon fill the land with birds. Bright plumage and song would abound. Lawn trees and hedges, pasture and grove, would be replete with nests. Each nest, it must be remembered, has a definite economic value. When it is robbed of eggs or young, or when the parent birds are captured or shot, a large number of insects are saved from destruction to continue their depredations on crops; for the young in the nest are fed almost exclusively on insects and consume them in immense quantities. Let the farmer remember that every bird destroyed, and particularly every nest robbed, is equivalent to a definite increase in insects with which he already has to struggle hard, and he will soon appreciate the fact that he has a personal interest and a strong one in the preservation of the birds. Robert Kennicott, a most careful and reliable observer, ascertained that a single pair of house wrens carried to their young about 1,000 insects in a day.[a] At this rate a young brood of wrens probably destroys, before leaving the nest, as many as 10,000 insects. According to the usual proportion in the food of young wrens about 6,000 of these are insects that devastate crops, including nearly 600 cutworms.

The æsthetic aspect of bird life appeals less strongly to the average farmer, but he should reflect that many, perhaps some of his family or

[a] Baird, Brewer, and Ridgway, "North American birds: Land birds," Vol. I, p. 151.

neighbors, find distinct pleasure in the presence of birds, purely as regards song, beauty, and general interest; and to these the absence of bird life would make an important difference in the enjoyment of the homestead. An abundance of birds about the dwelling, like a profusion of flowers, gives much added value in the eyes of all who properly appreciate the charms of nature. A home where robins, bluebirds, hummingbirds, wrens, chipping sparrows, catbirds, and orioles form an animated and friendly throng on bush and tree and sunny lawn or pour their notes from familiar vantage points, and where roses, honeysuckle, violets, jasmine, spirea, lilies of the valley, and morning-glories abound and fill the scene with beauty and the warm air with fragrance that floats in at the open windows, is far more attractive and of greater commercial value than one that is silent and bare. Birds will return year after year to the same spot to build their nests and rear their young, and when some spring fails to bring the bluebird to the apple tree or the oriole to the elm it is perhaps because lax laws and untrained character at some point to the southward have destroyed the life that seemed a part of the farmstead. Strengthening the law and developing a love for nature will save many such losses. Furthermore, friendly acquaintance with the living birds is an unfailing source of enjoyment to one whose interest has once been aroused, and should be encouraged, particularly in the youth of the country. Such acquaintance opens up new avenues of pleasure and new lines of thought, and brings a more intimate contact with nature. The influences it exerts are a good corrective in this perhaps too materialistic day. Its pleasures are refining in tendency. The boy that can enjoy the singing of a thrush or the nest-building of a robin is less apt to indulge in pursuits that lead to the formation of vicious traits of character, and will be likely, in consequence, to develop into a better member of society.

Every farmer should, therefore, cooperate heartily with those who are endeavoring to save the birds. Energetic measures are necessary, for the danger is great. Our centralized industrial system is an immense machine, the power of which is scarcely yet appreciated. A whim of a leader of fashion sets in operation a movement that with speed and certainty practically exterminates an abundant species. The rapid absorption of the wilderness carries destructive agencies everywhere and leaves no haven of refuge to the birds. Men and boys, paid or unpaid, professional or amateur killers, are waging a war of extermination wherever birds are found on which human desire has fastened its gaze. Earnest efforts to check this reckless and unwarrantable sacrifice of bird life have had an appreciable effect; but extraordinary means are required to insure complete success; and these can be had only through the support of the public, particularly in rural districts, where the destruction occurs and where the greatest injury

results. The movement can be aided by various means—establishing local societies, either as branches of the State society, where such exists, or as independent organizations; encouraging, in every way, study or observation of the birds by boys and girls, in school or out; posting lands and prohibiting trespass for the purpose of shooting or capturing birds; discouraging the use of firearms by boys; and recognizing at all times and in all things that whatever right man may have to destroy life for legitimate use, such right is founded on a regrettable necessity, and does not justify reckless extravagance or wanton cruelty.

INDUSTRIAL PROGRESS IN PLANT WORK.

By B. T. Galloway,
Chief of the Bureau of Plant Industry.

INTRODUCTION.

As population increases, more and more interest must be taken in the growth of plants. The questions of the supply of food and raiment are vital ones with any country, and the more dense population becomes the more pressing is the need for a careful study and consideration of all the matters involved in this problem. While the questions of a proper supply of food and clothing are vital, there are other problems connected with the growth of plants which are highly important, and these must also receive consideration in the development of nations. With increasing wealth, there always comes the demand for something more than the bare necessities of life in the way of food and clothes; hence there have been developed the various branches of horticulture, furnishing as they do many things which, strictly speaking, are not required to sustain life, but which nevertheless add to the health, happiness, and contentment of the people. With food plants, it is not enough that quantity alone should receive consideration, but quality must also play an important part. America owes much of her success and vigor as a nation to the fact that her climate is capable of producing plants which, as food, bring about in man the highest result, both physically and mentally. This happy result, however, is due to natural conditions and natural laws rather than to any systematic or concerted action on man's part to bring it about. The time will come, however, when the great advantages which nature has bestowed upon this country will be more fully understood, and a systematic effort will then be made to regulate the food supply so as to bring about the maximum mental and physical development with a minimum expenditure of time and money.

The object of this paper is to briefly review some of the advances made along the lines suggested above, emphasizing the manner in which the results accomplished are adding to the health, happiness, and wealth of all the people.

PROGRESS WITH CEREALS.

The chief cereals, including corn, wheat, oats, barley, rye, and rice, constitute nearly 50 per cent of the total value of all plants grown in this country, and they are, therefore, of the utmost importance in the consideration of any question affecting improvements in quantity or quality.

CORN.

Corn heads the list in value as a cereal, yielding 2½ billion bushels in 1902, valued at something more than a billion dollars. There has been no material change in the production of this crop in the last twenty years, with certain exceptions where the season was particularly advantageous, or vice versa. There is a promising field, therefore, in the matter of increasing production, providing this can be done without materially increasing the cost of the work. This field has been recently entered, and already encouraging results have been obtained. The yield of corn in certain fields or certain localities is found to vary greatly with conditions of soil and climate oftentimes practically the same. This indicates a marked difference in the individuality of different types, and suggests a way for the improvement in quantity by systematic selection of the best races for the purpose of increasing the yield and fixing it above the normal. Systematic work in this field has been inaugurated by the Department and a number of the State experiment stations. The Illinois experiment station has been particularly active in this work, and its experiments, extending over five years, have shown that if the methods of selection practiced at the station, which are entirely practical and within the reach of every farmer, were followed, the increase in production in Illinois alone for one year would have brought to the farmers of the State approximately $20,000,000. So important has been this work, and so thoroughly has it been appreciated by the leading farmers of the State, that an association has been organized for the special purpose of extending it, and this association is known as The Illinois Seed Corn Breeders' Association. The objects of this association are to establish distinct types and breeds of corn, to encourage and promote the growing of pure-bred corn for seed, and to protect farmers who desire to purchase pure-bred seed for planting purposes. Aside from the increase in production in corn, however, there have been marked improvements in the matter of changing the composition of the grain itself to meet certain special requirements.

The manufacture of oil from corn is now becoming an important industry. The oil content of the grain is a variable factor, just as is the starch content or the protein content. But the amounts of these various materials can be increased by the selection and planting of types giving a high yield of each particular material. In the case of oil, the greater the quantity of fats present the more valuable is the particular type for the manufacture of the product in question; hence there is opened a field for the growing of oil-producing corn for which there is likely to be an increasing demand and a good price. By far the most important question connected with the improvement of corn, however, is that which relates to its value as a well-balanced food, either for growing animals or for the human family. As is pretty well known, corn is not a perfect food in the sense that wheat and oats are.

There is a deficiency in protein in corn which no doubt has had much to do with its inability to hold its own as a food, especially in foreign countries, with such grains as wheat, oats, and rye. With a grain grown so extensively as corn and used in such enormous quantities as food, it has long been a question how to increase the protein at the expense of the carbohydrates. Like the other constituents of corn, however, its protein or nitrogen content varies, and thus is opened the way for the development of races or types richer in this important element than those now in general use. Important investigations along this line are under way in a number of different places in this country. Some attention has been given by the Department to this phase of corn improvement, especially in the matter of producing varieties rich in nitrogen, by breeding and selection, and suitable for hominy and other prepared foods. The Kansas experiment station and the Illinois experiment station have both been engaged in important work along this line for several years, and the results obtained by them are of the greatest interest and value. Briefly, it has been demonstrated that different varieties of corn show great differences in the nitrogen content. Not only has this been noted in different varieties, but it is found to exist in different ears of the same variety and even in different grains of the same ear. By the selection of varieties containing a high percentage of nitrogen, it has been possible to develop strains containing an increased amount of this desirable material, and it has also been shown that the ability to continue this can to a certain extent be fixed in the variety.

Aside from the foregoing important questions relating to the improvement of the corn crop and the growing of the same, attention should be called in passing to the value of recent systematic work in the matter of making the individual farmer familiar with the importance of good seed and the necessity for adopting proper safeguards in the prevention of diseases. Corn smut has long been a serious scourge, and before its nature was understood no particular effort was made to combat it. In the last twenty years, a conservative estimate of the damage done by this disease would aggregate $40,000,000 to $50,000,000. In all probability the loss would have been $10,000,000 more in the last eight or ten years but for the systematic educational work done by this Department and the State experiment stations.

WHEAT.

Wheat is the next most important cereal after corn so far as money value is concerned, and the recent progress made in its development has been greater than for any other grain. This is probably accounted for by the fact that there was more urgent need for improvement here than for corn and other cereal crops, owing to the great variation in yields and prices, the various effects of climatic conditions, and the injuries produced by diseases and other agencies. The total yield of

wheat in this country for 1902 was in round numbers 670 million bushels, valued at $422,000,000. About one-third of this wheat was exported, either as wheat or flour, leaving something like 435 million bushels for home consumption. Notwithstanding the fact that the total acreage planted to wheat and the total yield have been steadily increasing during the past twenty years, the amount produced per capita has decreased. In other words, population has increased faster than the yield of grain, and if this continues, the time may come when it will not be possible to supply the home demand. It is not worth while to enter upon a mathematical demonstration of the foregoing statement, as the only object in calling attention to it is to show one of the necessities for far-reaching work in the matter of cereal improvement. Enough has been accomplished to show that, with concerted and intelligent effort, there is no need to fear that this country can not continue to supply its own needs and the needs of a good part of the rest of the world besides. The efforts that have been made in this direction are already bearing fruit, as will appear from the brief statements here given of progress made.

The work of the Department during the past eight years in this particular field has been confined to six principal lines: (1) A demonstration of the value of improved methods of cultivation, principally as relates to tillage, time of seeding, etc., as affecting the yield; (2) a demonstration of the value of adapting different varieties to different regions; (3) originating new varieties by breeding; (4) improving the yield and the quality by selection of seed from races or types; (5) the introduction of new and promising varieties from foreign countries and the placing of them where they seem most likely to succeed; and, (6) demonstrating the efficiency of certain methods of preventing diseases, principally rusts and smuts.

Those who have not taken the trouble to study the methods of cultivation of cereal crops in this country are hardly aware of the great discrepancy in the yield of wheat in regions where conditions of climate are practically the same. Farmers have been accustomed so long to having constantly at their disposal virgin soil, that comparatively little effort has been made to systematically increase the yield of wheat by proper methods of tillage. Tillage is used here in a broad sense and refers to methods of planting, seeding, fertilizing, etc. The average yield of wheat in this country is slightly more than 13 bushels per acre—small when compared with that of Germany and the United Kingdom, where under high tillage the average yields are 26 bushels and 31 bushels, respectively. It is not beyond reason to say that with even slight attention to methods of tillage, the average yield of this country could be increased from 1 to 2 bushels per acre at little or no additional expense. This estimate does not involve a consideration of the question of fertilizers at all, but means that with proper attention to the right kind of cultivation of the soil, cultivation at the

proper time, and better methods of seeding, a fair average increase of 2 bushels would not be an exorbitant figure. This would mean a total increase for the entire country of nearly 100 million bushels, something certainly worth striving for. With a view to bringing about a better understanding of this important work, the Department has for several years been engaged in calling attention to the methods of increasing yields by tillage, and in proving the efficacy of its suggestions by practical demonstrations. A number of experiment stations have also been actively engaged in this work, and already the results are beginning to be apparent, especially in the more thickly populated districts, where the demand for higher yields is becoming more and more imperative.

Considerable work has been done in showing the value of adapting different varieties of wheat to regions where they are likely to be most successful, and promising results are already becoming apparent. Systematic studies have shown that this country can be districted in such a way that varieties of wheat particularly adapted to certain districts can be planted therein and will give better results than if indiscriminate planting is followed. This work has also led to the rapid extension of the wheat-growing area into the western semiarid districts. Prior to a few years ago little attention was given to the possibilities of growing wheat in the great semiarid districts of the West. By semiarid, reference here is made to all that country between the ninety-ninth and one hundred and second meridians; also to portions of certain Western States—Washington, Oregon, and others—where crops are generally grown without irrigation. A considerable part of this territory is available for the growing of certain classes of wheats, as has been demonstrated by the work of the Department. It is true that the yields here are not as heavy as they are in some of the more humid sections of the country, but even under arid conditions, if all of this region were planted, as well might be the case, it would increase the total output of the important grain under consideration in all probability 80 million to 100 million bushels each year. This, on a conservative estimate, would add to the wealth of the country not less than $50,000,000 to $60,000,000 annually.

In the matter of originating new varieties by breeding and in the improvement of the yield and the quality of the grain by selection of seed from races or types, considerable systematic work has been inaugurated by the Department and some of the experiment stations, notably the Minnesota station. It is here that some of the most promising results have been obtained, results which are far-reaching in their nature and which show beyond question that with proper attention to detail there is no reason why this country need fear anything in the way of a diminution in the quantity or quality of this important marketable product. Not only has it been shown that the quality of the grain for special purposes can be materially changed to

suit necessary conditions or wants, but that the prolificacy of races or types can be fixed by careful and systematic seed selection.

Some of the most striking immediate results in the industrial development of plant work have been accomplished by the introduction of wheat from foreign countries. Careful and systematic investigations of the wheat-growing conditions in other countries have been inaugurated by the Department and have been carried on for a number of years. In the light of information gained by this work, it has been practicable to secure from foreign regions varieties of wheat adapted to certain conditions here. The introduction of the macaroni wheats is the most striking example of this work. For a good many years efforts were made to introduce these hardy wheats from Russia and other countries. For some reason, however, the wheats were never received with any great favor until recently, when this Department began a systematic endeavor to bring them in and place them where they would most likely succeed. Largely through the efforts of the Department, from 75,000 to 100,000 bushels of macaroni wheat were harvested from the semiarid regions of the Great Plains States in 1901. The interest taken in this work and the fact that a number of European manufacturers had expressed a desire to contract for large quantities of this wheat if it could be purchased and would stand the proper test, led to its general planting so far as seed was available during the year 1902. At a conservative estimate, not less than 1½ million or 2 million bushels were grown this year from the product of the seed of the previous season. The industry, so far as growing wheat is concerned, therefore seems to be established, and it now remains to interest manufacturers and others, so that the product when grown will find a ready market. It is safe to say that probably within ten years or less the output of this wheat from the semiarid regions of the West will aggregate 20 million bushels, all of it being grown on land which a few years ago was considered practically worthless owing to deficiency in rainfall.

Some of the most valuable work of the Department has been in demonstrating the efficacy of certain methods of preventing serious diseases of wheats, principally rusts and smuts. The first efforts of the Department were directed to testing the practicability of treating rusts by the methods usually followed in handling other diseases of crops. These were found to be ineffective; consequently they were abandoned and lines of work inaugurated which had for their object the breeding of rust-resistant sorts and the substitution of rust-resistant kinds for those known to be subject to the disease. By persistent and systematic work in this direction, the farmers of the country have been able to adopt measures of great benefit. There is no way of approximating the injury to grains of this country through the attacks of rusts. Some years it will probably aggregate 10 or 20 per cent, other years less, according to the character of the season. Probably

every year not less than 100 million bushels of various grains are actually destroyed by these fungi, and the importance, therefore of eliminating as rapidly as possible the varieties which are known to be subject to the parasites becomes apparent. The smuts of wheat are not so serious, but at a conservative estimate they no doubt cause an annual loss of 25 million to 30 million bushels. The smuts are now controllable, as has been demonstrated by the work of this Department and the experiment stations, but in order to obtain the full value from the discoveries that have been made, a great deal of educational work remains to be done. The experience of the Department has been that after remedies for diseases of this kind are discovered, the efficacy of the treatments must be many times demonstrated before they will be generally adopted by the conservative farming element.

OATS, RYE, AND BARLEY.

Not as much attention has been given to oats, rye, and barley in the matter of improvement as has been the case with the preceding crops, corn and wheat; but considerable has been done, and the results in the aggregate, so far as money value is concerned, are worthy of note. The principal work with these crops has been along the line of new introductions and careful studies of diseases and their treatment. Oats have been brought from Norway and Sweden and placed in the Northwest, where most promising results have been obtained from them in the way of increased yields. Special attention has been given to the introduction of Bavarian barleys suitable for brewing purposes, and these are well established in a number of places. By far the most important practical work connected with these crops has been the systematic studies made of the diseases affecting them and the treatment of these diseases based upon the knowledge thus gained. The smut of oats has received special attention, and so successful has the work of controlling this pest become that failure is unlikely if the simple methods now recommended are followed.

The oat crop of the United States for 1902 was, in round numbers, 987 million bushels, with a farm value of more than $300,000,000. The injury to this crop from smut can now be pretty accurately determined, thanks to the very painstaking work of a number of investigators at widely scattered points. A conservative estimate of the annual loss during the past eight years would be 6 per cent of the crop. It is safe to say that the propaganda work in the matter of treatment has resulted in keeping this loss down by at least 1 per cent, if not more. This may seem a small thing, but it is not when the conservatism of the farmer and the difficulty of introducing anything like a universal practice over such a wide extent of territory are considered. A saving of even 1 per cent, however, would represent a money value in eight years of more than $15,000,000.

RICE.

No more striking example of the building up of a new industry is to be found than that of rice. This important grain was one of the earliest introductions, but for nearly two hundred years the main output was from South Carolina, Georgia, and adjacent States. At about the end of the civil war Louisiana began to make rapid progress in this industry, and during the past six or eight years this State and Texas have rapidly come to the front in rice-producing capacity. This is due to a number of causes, chief of which may be mentioned the adoption of improved methods of cultivation, whereby the capacity of the individual farmer for production was enormously increased, and the introduction and distribution of new forms or types of rice, which upon trial were found to be specially fitted for the conditions prevailing in the two States in question. In consequence of this work, the total production of rice in this country has increased from about 115 million pounds in 1898 to 331 million pounds in 1902. Of this last amount, Louisiana and Texas alone produced more than 90 per cent. With the rapid increase in home production, the quantity imported has fallen from 154 million pounds in 1899 to about 70 million pounds in 1902. As a matter of fact, these 70 million pounds do not really represent the amount required to meet the demand on account of lack of sufficient production in this country. There is always a large importation of rice on the Pacific coast for the Chinese and Japanese who reside in that locality. From 30 million to 40 million pounds are annually brought in for this purpose, and will continue to be brought in, as the Chinese and Japanese will not use the rice grown here. During 1902 there were sent to Porto Rico 52,633,700 pounds of American-grown rice. Thus, other markets are being opened for this important product. As a result of the propaganda work on rice culture in Louisiana and Texas, the increased value of the land alone in these States, where it has been demonstrated that rice can be profitably grown, will aggregate $10,000,000, while the annual increase in money from the rice will exceed $1,000,000. There are still available in these two States 3 million acres of land suitable for rice growing, and there is every reason to believe that within the next five years the extension of the industry will enable this country to come to the front as an exporter of rice. Leaving out of consideration, however, the question of exportation, it is gratifying to know that the consumption of rice in this country is rapidly increasing, owing to the well-organized effort being made in the way of acquainting the people with the value of rice as a food and the many ways in which it can be used for this purpose. It has been estimated that the consumption of rice might be increased to 40 pounds per capita with benefit to the people, both from the financial standpoint and from the standpoint of health. This consumption of 40 pounds per capita would include only rice used in soups and such

other substantial foods, and would exclude the grain when used for pastry and other similar purposes. With the present population, the consumption of 40 pounds per capita would require approximately 3 billion pounds of rice. It will be seen, therefore, that there is abundant opportunity for the encouragement of the growing of this crop for domestic consumption alone. When it is understood that this remarkable increase in the production of rice in Texas and Louisiana has been largely brought about through the encouragement afforded the industry by the Department in the matter of securing new and desirable varieties and in other ways, the value of such work will be more fully appreciated.

PROGRESS WITH HAY AND FORAGE CROPS.

The importance of the hay and forage crops of the country will be better understood when it is known that nearly 15 per cent of all improved land is devoted to their cultivation. With an annual value of nearly half a billion dollars, hay and forage occupy something more than 60 million acres of land. There are probably no greater problems confronting agricultural investigators and experimenters to-day than those having for their object the securing of facts which will give the farmer a reasonable assurance of better results with forage crops. Not only must the question of forage for forage alone be considered, but the question of forage crops as a part of a general plan for the improvement of the soil must also receive attention.

The enormous quantities of agricultural products shipped out of the country every year have already been noted. Corn, wheat, oats, and cotton necessarily take much valuable fertilizing material from the soil, and when it is shipped away it is, of course, a total loss. There is not so much urgency in the matter of mineral foods, but the question of nitrogen supply is an important one. The annual value of the nitrogen alone shipped out of the country in the crops above mentioned amounts to more than $95,000,000. The great importance, therefore, of adopting some measures which will restore this enormously valuable material becomes apparent. Leguminous forage crops are especially valuable for this purpose, and the extension of their growth is doing more and more to restore the fertility of the land. The cowpea is one of the most important crops for the purpose in question, and largely through the efforts of this Department and the experiment stations its use for forage and for restoring worn-out lands is becoming more and more extensive each year. It is now grown in all the States south of the Ohio River, and in 1899 there were planted nearly 800,000 acres to this crop. There were obtained from this planting approximately 6 million bushels of seed, valued at $1 per bushel. Basing an estimate on the amount of nitrogen stored in the soil by this crop, it is fair to say that fully 15 million pounds of this valuable substance were collected and retained as a result of the planting of the

cowpea alone. This at 15 cents a pound would be worth something more than $2,000,000 for nitrogen alone. It must be remembered that such crops as cowpea, soy bean, velvet bean, etc., also add materially to the value of the land by improving its physical condition and rendering available substances which would remain inert but for their action.

Another important crop which is of great promise to the South, and which the Department and experiment stations are actively pushing, is the velvet bean. Alfalfa is also a very important crop, especially for the western portions of the country, and for many sections of the East and South where soil and climatic conditions are suitable. Alfalfa has been cultivated from the earliest days, but it is only in recent years that its use has become extensive in this country, largely through the educational work carried on by the Department and other similar organizations.

One of the most important lines of work undertaken by the Department has had for its object the improvement of the forage conditions in the West, especially those of the great ranges. As the range land is being rapidly taken up, the necessity for improving the conditions on the remaining portions of this important territory becomes more and more imperative. The demand for cattle is becoming greater, owing to the increasing population and increased consumption, and thus there is created an urgent necessity for a betterment of conditions, so that a smaller area of land can support a greater number of cattle. There will always remain many millions of acres of western land which can not well be irrigated and which will not be suitable for general farming operations. These lands, however, are especially adapted to the grazing of cattle, and what is urgently needed is to demonstrate the possibility of improving the forage so as to increase the facilities for this purpose. Already very encouraging results have been secured by preliminary work in a number of the Western States and Territories, it having been shown that the productiveness of the ranges could be materially increased without any material addition to the cost of the operation.

Aside from the foregoing questions, there are many other important ones having a bearing on the improvement of meadows and pastures in the more humid regions so as to offer better facilities for the growing of cattle. The pastures and meadows of the United States do not as yet compare favorably with those of other countries, and much remains to be done in the matter of improving them, especially the pastures.

PROGRESS IN COTTON IMPROVEMENT.

Cotton has long been one of the leading crops of this country, ranking next to corn in this respect. It is not the purpose of this article to mention the many ups and downs that have followed the growth of this crop before and after the civil war. The past few years have

witnessed a remarkable improvement in prices, and as a result the industry as a whole has been greatly encouraged. So far as this article is concerned, attention may be called to a number of improvements in cotton culture along special lines, the work having been undertaken not so much to encourage a general increase in production as to aid certain phases of the work to the end of enabling the individual planter to reap greater profits therefrom. The lines which these investigations have followed are: (1) Studies of diseases with a view to checking their ravages; (2) the development of types of cotton which could be grown with no more expense than the old forms and yet would yield greater profits; and, (3) the introduction and growth of types of cotton for which we annually send out of the country large sums of money.

In reference to diseases, it may be said that the losses from them, as a rule, fall heavily on the individual grower. This is particularly the case with some of the higher types of cotton, such as the Sea Island varieties, which are planted in a comparatively limited way, but which yield good profits owing to the finer qualities of the staple. The Sea Island cotton industry is a very important one, and a few years ago it was threatened by a serious disease. The disease attacked the roots of the plants, oftentimes affecting whole fields, thus greatly decreasing the yields and threatening the entire industry. The first efforts of the Department were in the direction of determining the cause of the disease. This was found to be a minute fungus which, through its action on the roots, cut off the water supply and caused the trouble, to which the cotton growers had given the name of "wilt." The cause of the disease being known, the next step was to determine whether the attacks of the fungus could be prevented by the application of fungicides either to the plants or to the soil. This work was not successful, but the negative results obtained were of value, for they pointed out the futility and uselessness of expending money in this direction, something the cotton growers were doing to a considerable extent. While this work was in progress it was noticed that here and there throughout the fields of cotton there were certain stalks which were resistant to the disease. This suggested the plan of obtaining wilt-resistant types by careful selection. The work was put in operation, but in order to make it of the greatest value, many other points aside from the question of resistance to disease had to be considered. All the obstacles, however, were eventually overcome, and as a result the Department has secured resistant sorts, thereby succeeding in reestablishing this important industry. The results secured here apply not only to the Sea Islands, but to many other parts of the South where the wilt occurs and where the losses are oftentimes quite serious. It has been estimated on reliable authority that the loss from wilt alone is anywhere from $250,000 to $500,000 annually in certain sections of the South, and, as already pointed out, these losses may now be successfully overcome by the planting of resistant sorts, the seed of which is now being distributed

by the Department. In the development of new types of cotton for special regions and special purposes marked success has been attained. These investigations were started only a few years ago, and at that time crosses were made between some of the Sea Island sorts and the Upland kinds in the hope of producing a long-staple Upland race. The importance of this work will be understood when it is known that these longer staples are worth from 15 to 20 cents per pound, and that there is a constant demand for them. Already good success has been attained in this work, varieties having been produced by breeding which give a strong lint from 1¼ to 1¾ inches in length. These types or forms have the additional advantage of producing large bolls like the Upland cotton, and the bolls, furthermore, open well and are easy to pick. The value of this work to certain portions of the South can hardly be estimated, and as the demand for the finer grades of cotton increases it is safe to say that where special attention is given to these finer sorts the profits from cotton growing can be materially increased.

The United States imports annually about $6,500,000 worth of Egyptian cottons. These cottons are used largely for special purposes, and a few years ago the Department inaugurated experiments to determine whether or not the varieties so successfully grown in Egypt could not be produced here. Efforts have been made not only to grow these cottons in certain parts of the South where this crop is usually produced, but also to introduce them in portions of Arizona and southern California where irrigation is practicable and where the conditions are similar to those in Egypt. Already enough has been accomplished to lead us to believe that within a few years this country will undoubtedly be able to produce a large part of the cottons which are now imported.

CONCLUSION.

In concluding this sketch of some of the more important advances in industrial progress in plant work during the past few years, it may not be out of place to call attention briefly to the important results which have been accomplished in ways less specific than those already described, but which, nevertheless, are vastly important so far as the welfare of the country is concerned. Reference is made to the cumulative educational effect of the Department's work, aided by the very efficient service of the State agricultural colleges, experiment stations, boards of agriculture, and other similar institutions. The American farmer is the first representative of the greatest of all industrial pursuits to break away from the conservatism which has for ages been the steadfast tenet of the tiller of the soil. This we attribute largely to the work of the institutions already mentioned in gradually familiarizing farmers with methods of improving their conditions, resulting in the development of a system of agriculture second to none in the world.

SOME ENGINEERING FEATURES OF DRAINAGE.

By C. G. Elliott,
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INTRODUCTION.

Whatever may be said regarding the value of drainage in its various relations to industrial progress, its most far-reaching and lasting benefits arise from purely agricultural sources. It has been the means of greatly increasing the productive capacity of large areas and contributing to the comforts of country life.

Those who are unacquainted with the principles and practice of drainage for agricultural purposes have but to compare the unproductive swales, overflowed river bottoms, and limitless swamps which may be found in partially developed sections of our country with some of the most productive farm lands and prosperous communities of this and other countries, to understand in some measure the magnitude of the results which have been brought about by the practice of drainage. The engineering and legal difficulties which have been surmounted in the accomplishment of these results have enlisted the services of prominent statesmen as well as able engineers. In recent years the subject has attracted the attention of discerning business and professional talent to such an extent that the intelligent development of lands by methods known to the engineer is becoming better understood and more widely practiced.

The occasion for increased interest in this subject becomes more pronounced each succeeding year. In the opening up of a country it is natural that cultivators should first seek out and appropriate those lands which, by reason of their location and natural condition, are best suited for productive purposes, and can be cultivated with the least possible outlay of labor and capital. The neglect of waste lands, whatever their condition or area, occasions but little concern as long as there is a sufficient acreage of easily accessible arable land to occupy the attention of the agricultural people. With the increase of population and a corresponding added demand for food products, the reclamation of waste lands by drainage in such a manner as to fit them for the production of valuable crops, and the improvement of those already cultivated for the purpose of adding to their productive capacity, have assumed an important place in both agricultural and commercial activities.

Not only is the reclamation of land required in humid regions, where it has been supposed that the art of land drainage is alone applicable, but irrigated areas in the West furnish many instances which emphasize the need of drainage for lands which have been reclaimed by the artificial application of water. In fact, it may be said with truth that all lands require drainage, either by natural or artificial means, if they are to be relied upon to yield their best fruits to cultivators. A proper regulation of the quantity of soil water is necessary, be it furnished by rainfall direct upon the surface or by methods used in irrigation. The problem which confronts the engineer contains three important considerations which he should take into account: (1) The quantity of water which should be removed from the soil; (2) the plans and methods to be employed in accomplishing it; and, (3) provisions for the proper disposal of the water removed.

DRAINAGE OF RAINFALL.

With reference to the division of this subject most commonly recognized--that is, the drainage of lands receiving their water from rainfall—it may be said that the quantity to be removed is subject to several modifying contingencies for which due allowance, as far as practicable, should be made. This phase of the subject, when discussed in works on drainage, is often dismissed with a mere reference to the average rainfall of the locality and a few remarks upon the value of such data in planning an efficient drainage system. It is not the average rainfall with which we are concerned in land drainage, but the maximum precipitation at various times during the growing season. This should be considered in connection with conditions of soil and weather at such times. It is not infrequently the case that after a season of drought a rainfall of 2 inches of depth in twenty-four hours may be fully absorbed by the soil, while at other times and under different conditions a large part of a like precipitation must be provided for by either surface or underdrainage or a combination of the two.

SURFACE STORAGE.

The storage capacity of the surface of the land which may be used without detriment to its productive value occupies an important part in the plans for drainage, especially where large tracts are under consideration. The percentage of slope of an area toward its natural drainage courses and the obstructions which retard the surface flow of rainfall present engineering problems of a local nature. For example, where the tract is large and nearly level, the movement of water by both natural and artificial drainage is slow, and a larger percentage of rainfall is evaporated, stored in the soil, and used by the plants in a given time than where the slopes are sufficiently great to make the

run-off rapid, thereby overcharging main drainage channels for a short time and carrying off water which it would be better to have pass over or through the soil more slowly. For this reason the drainage of level areas of large extent can be accomplished with smaller main channels, considering their carrying capacity, than that of more undulating land with irregular and varying contour. It may be further said that the results arising from such drainage are more salutary, and have attracted wider attention than in the latter case.

As an example, it may be assumed that the main drainage of a tract of large extent and level contour may be provided for by a channel computed to carry one-half inch of water in depth from the entire area from which it receives drainage in twenty-four hours when the channel runs eight-tenths full, two-tenths of the full carrying depth being reserved for contingencies not entering into computations for channel capacity. The methods of draining the interior of the tract, and the subsequent uses to be made of the land, have a modifying effect upon the work which the main drainage will be called upon to perform. If done by systems of underdrains, with supplementary open-ditch laterals, the time taken for the removal of water will be extended several days, thereby making the maximum discharge required of the main channel sometimes 10 per cent less than where the entire work is accomplished by surface drains alone.

The considerations which will apply to land just described, with reasonable accuracy, will be far different for a tract of rolling or broken land interspersed with level areas. Here, again, the degree of slope and the changing character of the soil and surface conditions present a variety of important features for the attention of the engineer. The maximum quantity of drainage to be provided for in twenty-four hours may be one inch of depth, or even more, for the entire watershed, with many complex questions of interior drainage to look after. The aim should be in such cases to hold back and distribute the water from the more elevated lands rather than to concentrate it; to provide for its entrance into and passage through the soil rather than over it; to store a portion of it in the lower strata of the soil instead of hurrying it into the main drainage by the most direct course possible. At the same time, the level portions must be protected and drained in accordance with the requirements of their peculiar situation. A due regard to these considerations in the planning of drainage works for lands, such as just described, will retard the surface wash, prevent waste of soil from rolling lands which adjoin level flats, and conserve moisture needed for the higher lands, while, at the same time, it will assist in taking care of the drainage of contiguous low-lying or valley lands and arrest the distribution of rainfall through the soil by artificial drainage as well as by surface control. This is an important engineering feature of drainage which merits more attention than it

has heretofore received. While the quantity of water to be removed from soil and the plans for accomplishing it are analytically different subjects, it is not difficult to understand, from what has already been said, that in practice they are intimately connected. The quantity of water to be provided for in a given time will have much to do with the design of plans and methods of accomplishing the drainage of lands.

The details of this work involve the consideration of numerous local conditions. While the general principles are the same, the surveys, computations, and plans for the accomplishment of efficient and economical work in any particular locality should be evolved in accordance with the conditions and surroundings peculiar to it. The engineer's treatment of the case must be largely influenced by precedents and former practice under analogous conditions. In this regard, however, drainage engineering is not unlike other divisions of practical work directed by scientific methods, but investigations along this line have not been as persistently and carefully pursued as those for other divisions of hydraulic work.

DRAINAGE OF IRRIGATED LANDS.

While the drainage of humid lands has been practiced for years and its utility is well established, its importance in the cultivation of irrigated lands has only recently forced itself upon the attention of owners. The necessity for drainage here, however, arises from causes so different from those which prevail in humid areas, and the conditions of soil, methods of cultivation, and weather are so different that a description of them will be necessary to a proper understanding of the situation. Strange as it may seem, there are some areas now requiring drainage which were once almost destitute of soil moisture.

The water which has converted the desert into the productive farm is derived from streams supplied by the melting snows of the mountains. Portions of these streams are diverted at various convenient points after they leave the mountains and the desired quantity of water conducted for miles, by means of ditches, to those lands which it is destined to irrigate.

Laterals are taken out at favorable points and the water used upon lands until the last diminutive stream vanishes in the greedy sands of an unwatered plain. These ditches pass across the slopes and around the hills in such a way as to maintain the light grade necessary, and upon elevations sufficient to give water service to a large acreage of lower lands. The soil through which they are constructed often contains large quantities of gravel and sand, or, in some cases, laminated shale, making it the most unsuitable material possible through which to form a water conduit. In some cases they pass through gypsum formations, which material, besides having a remarkable

affinity for water, permits excessive leakage by reason of the loose structure which is usually a characteristic of such beds. When first constructed it requires some time to get water through the entire length of the ditches, and not a little expense is necessary to repair injuries done to them by washouts and the settling of bottoms, which take place during the early history of every canal. While these losses diminish greatly after the banks of the canals have become settled and the crevices closed by silt, the loss of water is never effectively checked where the canals pass through loose earth, but continue to add to the underground waters of the plain. This loss has been detected by comparisons of measurements of the quantity of water taken out of the stream with those representing the sum total of water distributed. This is called "loss by seepage," and varies from 15 to 95 per cent of the entire volume diverted from the stream. The waste finally reaches, at some lower point, the stream from which it was originally diverted, and is classified as "return waters."

Could the ditches pass through earth practically impervious to water, or could they be lined with some preparation to make them water-tight, the conditions which prevail on the lower lands would be far different, but owing to the great size and length of many of these canals, the difficulties and expense attending this process are such as to be practically prohibitory. The losses by leakage in most instances are accepted as contingents of irrigation systems. The elevated position of the water carried by the supply ditches furnishes a constant pressure head to every stream of water, however small, which finds its way through the bottom of the channel. To this head and to the permeability of the earth may be attributed the presence and dissemination of seepage water, which, in time, manifests itself upon lands which have been irrigated and successfully cultivated for a term of years.

The soils in most irrigated regions are deep and loose, containing a small percentage of clay, but rich in concentrated plant food. They are finely divided and possess great capillary attraction for moisture; and, moreover, their physical structure is such that they are most easily kept in perfect condition by judicious cultivation. Further than this, they permit a ready passage of water through them after capillary spaces have been filled. The rainfall is so far deficient that water must be obtained from supplies diverted from mountain-fed streams and brought and distributed by ditches. The effect of this application of water to soils under judicious management is remarkable, as the abundant and valuable products obtained from such lands attest. The irrigator applies water by surface flooding, using such quantities as his judgment and experience may dictate, feeling sure that any excess which he applies will speedily pass to the lower soil, which, under primitive conditions, being dry to a depth of from 40 to

60 feet, porous and open, affords unlimited drainage facilities. The large amount of leakage from the main canals for a time finds a ready and harmless exit into the lower soil. Under such conditions the under strata become a regulating reservoir, which receives by percolation the leakage from irrigation canals and drainage from overirrigation, thus securing to the cultivator as perfect soil conditions as can be desired.

FILLING UP OF THE SOIL WITH WATER.

Under such conditions it will be only a matter of time when the lower soil will become filled with water and this will rise until the saturation extends to the surface, similar to that with which we are familiar in humid climates. These conditions already exist in all of the older irrigated lands in such a degree as to call emphatic attention to the injury done and to cause no little concern regarding the proper treatment of the lands which have become saturated. That the injury to lands from this cause is increasing rather than diminishing and that some plan for their drainage should be made and put in operation are conclusions reached by careful observers of the changes going on in irrigated districts.

THE PROCESS OF SEEPAGE.

A few general facts observed in California and Colorado may be valuable to those who are unfamiliar with this new drainage question. As would be expected, soil water usually first appears on the surface of the lower levels of land, being brought there by percolation through the soil from some more elevated supply, which forces water through the soil more rapidly than its natural drainage facilities will remove it. In other instances it appears not far from a supply ditch, the underflow having apparently been arrested in its passage through the soil by some less pervious material which has caused the water to rise to the surface instead of continuing its course through the soil at sufficient depth to be harmless to vegetation, until it finally reaches some drainage stream. In the areas which are nearly level the appearance of the surface water is more general, the quantity depending much upon the texture and condition of the lower soil. The saturation of irrigated land by seepage from supply ditches and from overirrigation will alone destroy their productive value as effectually as surplus water is known to destroy the productivity of lands which are overcharged with rainfall.

ALKALI CONDITIONS OCCASIONED BY LACK OF DRAINAGE.

There is an additional menace, however, accompanying the saturation of these soils which is peculiar to them and which in many instances manifests itself before the water appears at the surface or is

at all troublesome to cultivators. Many of these soils contain considerable quantities of sodium chlorid, sodium sulphate, and sodium carbonate, which originate in the rocks from which the soils are formed and are distributed through them, forming an essential part of their fertility under normal conditions. Lands which up to a certain time have produced crops in quantity and quality to which no exception can be taken may, without apparent cause begin to deteriorate and continue to do so. Upon examination, it will be found that the alkali salts have accumulated near the surface in such strength as to destroy crops which had previously been successfully grown. Upon further investigation as to the cause, it is found that the abundance of water in the lower soil has dissolved large quantities of alkali and holds it in solution. The rise of water to a plane at or near the surface from which rapid evaporation takes place results in a deposit in solid form of all alkali contained in the water evaporated. The active capillary power of the more finely divided soils accelerates the upward movement of the water, the evaporation of which is rapid in the arid climates, resulting in a deposit which constantly increases from year to year. The first stage of this evil is but the forerunner of the more serious results which follow in the train of the oversaturation of irrigated soils, which must be witnessed in order to be fully appreciated. These general conditions are not uncommon to all of the older irrigated districts. The value of drainage to such lands for the purpose of restoring them to their former productiveness, as well as to arrest the progress of the evil when once detected, is sufficiently demonstrated to merit investigation by all cultivators of irrigated soil. In fact, drainage is the only efficient method known for removing alkali.

SOURCE AND MOVEMENT OF WATER TO BE REMOVED.

In the drainage of seeped land under irrigation there are a few fundamental questions which should be considered, the first of which is the source of the water to be removed. The prodigal use of water during the first years of the cultivation of the land under new ditches, together with the enormous losses of water incident to new construction, have contributed largely to produce the water-logged conditions now found in the lower soil. From the history of early irrigation in the Fresno district in California, it appears that a vertical depth of 5 feet of water was occasionally applied in a single irrigation, and the depth applied during a season would sometimes be equivalent to a total of 20 feet. Such extravagant use of water does not often prevail in the older irrigated regions, so that the water requiring attention in drainage is now for the most part derived from the seepage of supply ditches. It comes from the subsoil, and is subject to a constant gravity head furnished by water in the supply ditches, which always occupy a higher level than the surface of the

land irrigated. The supply is constant during the growing season instead of intermittent and occasional, as is the case of water from rainfall. The soil is of an open character, and permits the ready passage of water through it. It also has high capillary power and carries water to the surface with remarkable freedom and persistency, much more so than soils containing a large percentage of clay or coarse sand and gravel; hence the depth of drainage is an essential feature of its success, for the reason that soil water should be kept so low that capillary water will be appropriated by the soil and plants before it reaches the surface. This should rarely be less than 4 feet, and greater depth is frequently more efficient. A proper location of drains, both as to depth and position, is of first importance. After the source and movement of water have been ascertained, a single drain may frequently be so located as to intercept and conduct away water which might otherwise destroy the value of hundreds of acres of land. The reclamation of the tracts already seriously injured may be accomplished by the same well-directed measures. There are a sufficient number of instances of successful works of this kind in California and Colorado to establish its efficiency under wise administration. It may be added, also, that the failure of shallow drains and ill-directed location emphasizes the wisdom of careful investigations upon these points.

PRACTICAL DIFFICULTIES IN CONSTRUCTION OF DRAINS.

The practical difficulties of drainage construction in these soils are in some respects quite formidable. The earth is easily and cheaply worked when dry, but difficult and expensive to handle when wet, unless a bed of gravel is encountered; gravel prevents the slumping of the fine soil which, under saturation, becomes semifluid in consistency.

It is a fortunate characteristic of irrigated lands that the plane of saturation begins to lower as soon as the supply of water is turned out of the ditches, so that between that time and the beginning of the following irrigating season, ditches for either open or covered drains may be constructed not only with reasonable dispatch, but with an assurance of being in perfect condition when completed. The wisdom of carrying on construction work when soil water is at its lowest stage is apparent to all who have attempted such work in the deep and open soils of irrigated districts.

DISPOSAL OF WATER.

The disposal and use of drainage water derived from seeped lands is a matter of peculiar interest to irrigated regions, because of the value attached to the water as an irrigation supply. Its use, so far as ascertained, is wholesome and may be made without fear of any injurious results from alkali. It may be diverted from the drainage ditch or collected in reservoirs and thence distributed by the usual methods,

FIG. 1.—SEELEYS LAKE NEAR GREELEY, COLO., FILLED BY SEEPAGE WATER.

FIG. 2.—IRRIGATION PUMPING PLANT OF R. W. BRISCOE, 4 MILES EAST OF MALAGA, FRESNO COUNTY, CAL.

thus adding to the available supply of water for that locality. Such water has a value, in many localities a high value, and as drainage becomes better understood and more widely practiced the water will constitute an important commodity among landowners. In some localities in Colorado it is being developed by drainage works at private expense and appropriated as an additional irrigation supply. (Pl. XXIII.) Over 400 filings on seepage and drainage streams have been made in Colorado in the South Platte Valley alone, and proceedings at law in that State have affirmed the right of appropriators of such water to its use as against any subsequent appropriation which will divert or interfere with the flow of drainage or seepage streams already filed upon. The development of water by drainage works brings into prominence new legal phases of the water question, which have not thus far been made subjects of legislation, but which should receive early investigation and attention.

KINDS OF DRAINS.

The theory of drainage may appeal with much force to the landowner and he may have great confidence in the results of the work when carried out, but the matter will receive only a passing notice unless its practice is shown to be feasible and remunerative. This is a feature of the work which commands immediate attention. The different conditions existing between regions where rainfall is a direct source of soil water and where seepage from reservoirs and canals furnish it through underflow suggest a difference in the plans, but not necessarily in the kind of drains which may be used. Open ditches, by reason of the depth at which they should be maintained and the unstable character of the soil, entail a constant expense for cleaning, which is unavoidable. Where the ditches are seldom flushed, their filling by sand, vegetable growth, and surface rubbish carried by winds occasions a necessity for at least one annual cleaning. Box drains are in favor in Colorado, where the quantity of water to be carried does not require a drain of large capacity. The advantages claimed for them are that they are cheaply made and may be secured in place in wet soils with greater ease and certainty than earthen draintile and sewer pipe, which must be laid in short sections. They are used with success where field crops are grown. When constructed with no bottoms, as is common with those of small capacity, their usefulness is limited to low grades; otherwise underwashing will destroy the usefulness of the drain by throwing it out of position. The lasting properties of the lumber used for this purpose will be measured by the degree of continual saturation to which it is subjected. The drains used should be lasting as well as efficient. In fig. 13 is shown the manner of draining a field of seeped land near Greeley, Colo., which was made unfit for cultivation by leakage from the supply canal

adjoining. The drains are of the box pattern and laid about 4 feet deep. The diagram shows a profile of the water line, as determined

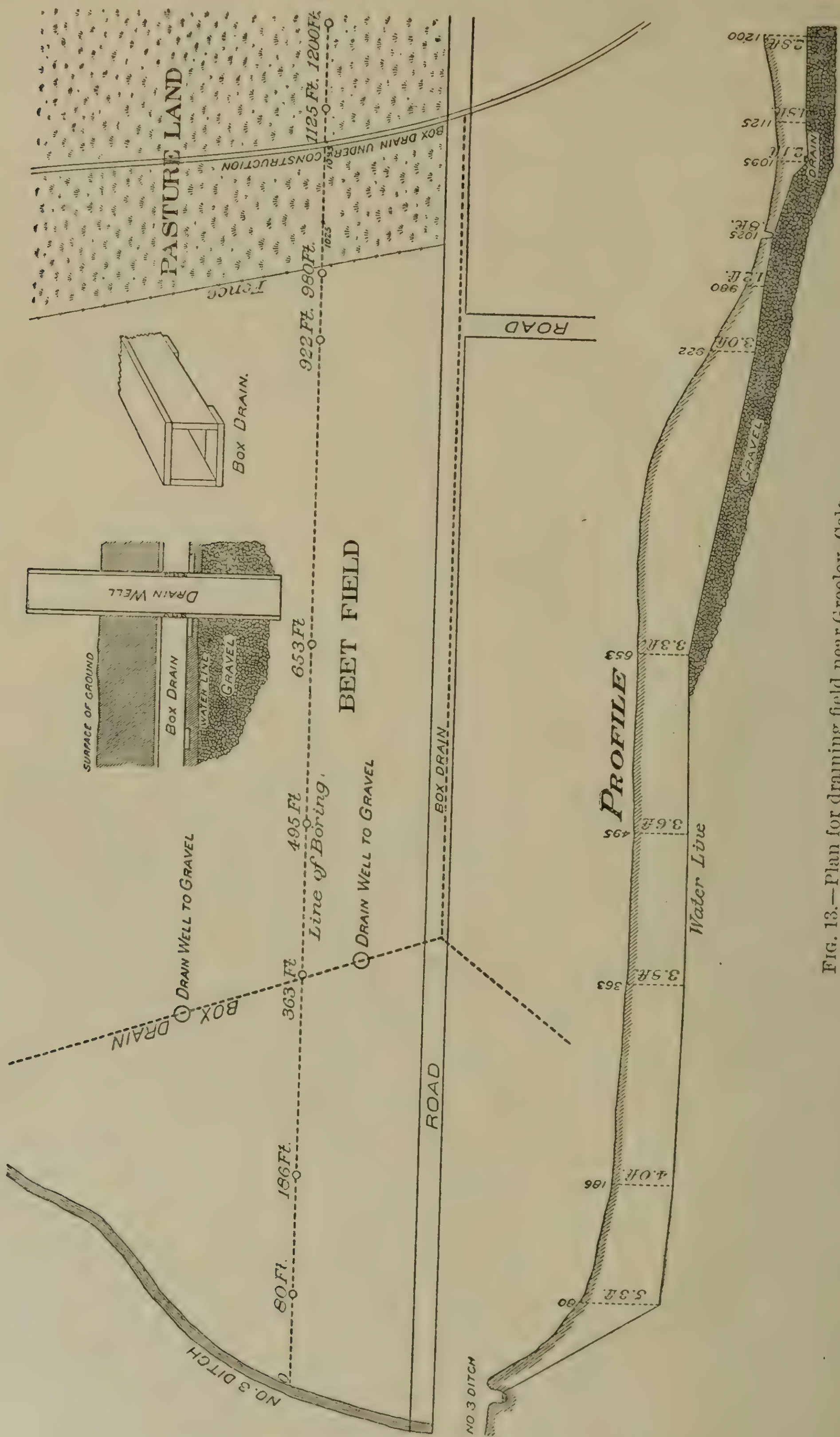

Fig. 13.—Plan for draining field near Greeley, Colo.

by borings made in August, 1902. There appear to be beds of gravel underlying this land in some localities. Where these beds could be

located, small curbed wells 10 inches in diameter were sunk into the gravel and the drains connected with the wells. It is claimed with good reason that these wells relieve the hydrostatic pressure of the free water in the gravel, the water rising in them and passing off through the drains instead of being forced upward through the soil. The thrifty crop of sugar beets growing on this land the first season after drainage was evidence of the success of the work. At the time these examinations were made a larger and more extended drain was being constructed in an adjoining field occupying a lower level. The profile of the water line shows the need of an additional drain, which will be laid approximately parallel with the supply canal.

Stoneware draintile constitutes an ideal material for underdrains. Owing to the practice of constructing such drains when the soil is saturated with water, there has been some difficulty experienced, in Colorado at least, in placing and maintaining the tile in position and also in keeping them free from sand. Their excellence as a water conduit and their durability are unquestioned. Their cost, however, being much greater than lumber, stands in the way of their adoption in localities which are distant from manufactories.

OPERATION AND LOCATION OF DRAINS.

Notwithstanding their expense, draintile are used with success, to a limited extent, in the fruit lands about Fresno, Cal. A provision for keeping the lines free from small roots, which constantly seek the flowing water, and would soon fill the drains, is found necessary. This is accomplished by passing cylindrical wire brushes through the drains every few months. Manholes, for the purpose of obtaining access to the drains for this purpose, are maintained at distances of 400 or 500 feet along the lines. Where these soils are chiefly occupied by trees and vines the drains must be scoured periodically by some process similar to the above, which will constitute an expense for maintenance peculiar to such localities. For this reason, and also because the grades are light, perfect work in the construction of drains must be secured.

The objection is urged that some kinds of drains are not effective; that water fails to enter them in sufficient quantity to accomplish the desired work; that, notwithstanding their presence, the land they are intended to benefit remains undrained. It is true that there are many instances which apparently support this conclusion. The writer has witnessed cases where underdrains were discharging water in continuous streams, yet the soil directly over them was saturated. In other instances the soil in close proximity to the drain was dry and productive, while 15 feet distant it was producing only water grasses. Open drains are liable to the same objections. The failure of the drains in the cases referred to was owing not to the material of which

they were made, but to their faulty location, either in surface position or depth or both. Proper surface position and proper depth are essential factors in the successful drainage of seeped lands. Since the source of the water is underground, its course must be found and the drains so located as to intercept its flow in the most effective way. This constitutes one of the arts bearing directly upon the successful drainage of irrigated lands.

It is, however, sometimes no easy task to locate drains properly. In this connection it is interesting to note that no greater impetus was given to the practice of drainage in England than at the time that Joseph Elkington, a Warwick County farmer, unlettered and ignorant, became so proficient in locating surface water and in arresting its course and leading it away that he became famous in neighboring counties as well as his own in draining soil which had hitherto baffled expert engineers. In recognition of his great service to agriculture, Parliament, in 1795, voted him the sum of £1,000 sterling. The Royal Agricultural Society previous to that time commissioned one of its members to collect and publish such information as could be obtained from Mr. Elkington in order that his art might be made available to the people. The same importance should be attached to the location of underground water in irrigated lands. A failure in this particular is largely accountable for the charge sometimes made that water does not enter the drains. The writer calls to mind a field on a farm north of Longmont, Colo., that has been drained thoroughly with the exception of one portion of about 2 acres, which, notwithstanding the presence of drains around and through it, remains a swamp. The source of supply has not been found.

While upon this most practical subject pertaining to drainage, reference may be made to fig. 14, in which are well represented two kinds of drains, as well as two systems of location, which are found in adjoining fields on farms northwest of Greeley, Colo. In the one, a system of tile drains has been laid about 4 feet deep through the land immediately affected by seep water; in the other, an intercepting ditch has been made for the purpose of cutting off the water from the ditch before it does injury to the field. Each plan apparently accomplishes the work intended. The tile drains furnish a continual stream and the growing beets on both fields show equal thriftiness. There is a difference, however, in the cost of the two, and borings show that the water line is lower in the land drained by the single cut-off ditch than in the field where tile drains have been used.

FIELD ENGINEERING.

The location of drains should be made when the ground is wet, so that the outcropping water, its effects, and the course of its underflow can be ascertained by suitable test borings. After this has been done,

advantage should be taken of the fact that the level of soil water recedes between the irrigating seasons and sinks so low that drains may be constructed in dry ground. The lines should be surveyed the grade located, and the drain, of whatever kind used, constructed in accordance with the survey. The risk and expense arising from caving ditches, running sand, and all of the contingencies incident to such work would in this way be largely avoided and the drains completed under the best possible conditions. Here is a field for the investiga-

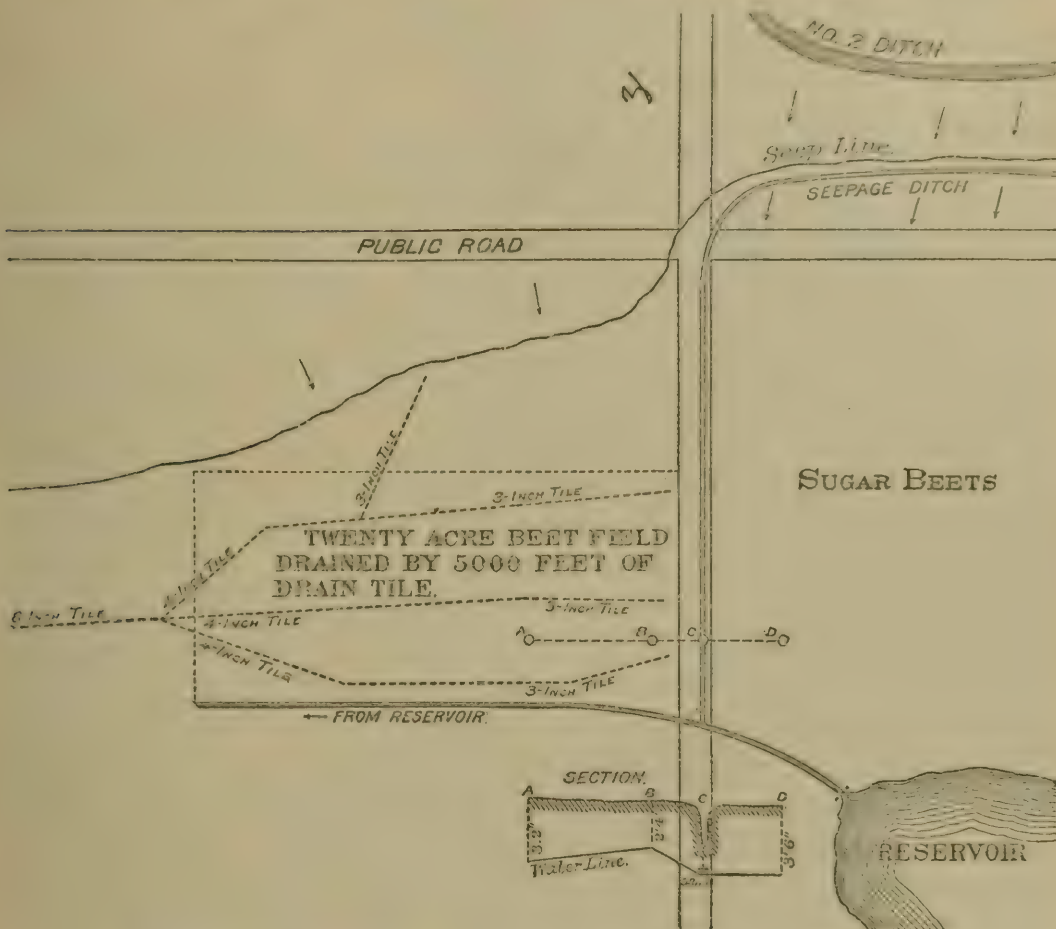

FIG. 14.—Drains and systems of location on farms northwest of Greeley, Colo.

tion of the minimum grades which may be permitted under the several conditions to be considered and the best methods of disposal of the water, together with size of drains and specifications of their construction.

THE NEW DRAINAGE FIELD.

There is no question but that there is ample room for profitable investigation in this new drainage field. The irrigation of the arid lands of the West has developed a necessity for drainage which is destined to follow in the wake of the reclamation of all desert land. Owners of such lands should be early apprised of this menace to their property. Care in the application of water and watchfulness for the

first indications of saturation or appearance of alkali, with proper preventive measures, will go far toward arresting this growing evil in newly developed districts. It is well proved that alkali in cultivated lands is the result of oversaturation, arising principally from the seepage from ditches. It seems equally well assured that if the water line of the soil can be reduced by drainage to within 5 feet or more of the surface the accumulation of alkali to an injurious degree will be prevented.

Sufficient work has been done in Colorado to demonstrate that judicious drainage will reclaim lands already saturated, that it will prevent the rise of alkali, and that land which has become water-logged and injured by alkali may by this means be restored to its former productiveness. The success of this promises to be as marked as that of drainage in well-watered States of the East and Middle West. Since the time underdrainage was introduced in New York, in 1836, its value in reclaiming, restoring, and developing the soils of the country has been incalculable. The work still goes on as a well-tried and standard method of increasing the productiveness of the soil. Drainage in the irrigated districts promises equally important results, and will be more universally practiced as the lands grow older. When lands have once been proved to be profitable under irrigation it is poor policy to permit them to be ruined by the same agency which has developed their productiveness. Among the numerous instances of injury to lands from this cause, which may be found in different States, there are doubtless a great variety of conditions to be met and many unsolved problems relating to their reclamation, yet some application of the well-established principles of land drainage will be of utmost service. This problem has been considered as applying only to those lands which have been proved by actual cultivation to be of the highest productive value under ordinary irrigation practice. They have not been depleted in fertility, and for that reason abandoned, as is the case with long-cultivated lands in the East. Their value is not impaired for lack of market for their products. On the contrary, they are fertile in every desirable particular, and are capable of producing crops of superior quality, which are sought for in the markets. The lands requiring drainage are often the choicest, so far as location is concerned, and more desirable than new and unimproved areas. The suggestions regarding their restoration to the realm of profitable irrigated lands have been deduced from somewhat limited investigations, and their application to lands in similar conditions in other States may be subject to revision. The subject is certainly one of such importance as to merit a full examination in every district where the conditions herein described prevail.

TOP WORKING ORCHARD TREES.

By G. Harold Powell,
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INTRODUCTION.

The top working of orchard trees is concerned with the insertion of buds or scions in the tops of the trees after they are established in the orchard. It may be practiced upon trees of bearing age which it is desirable to transform into better sorts; or it may refer also to trees recently planted which may be top-worked for other purposes. The fruit grower may have planted varieties that are not adapted to his climatic conditions, or when the orchard reaches bearing age, may find that the varieties are not true to name, and are inferior or even worthless. In many of the orchards that were planted about twenty-five years or more ago, especially in the Southern States, the trees are of varieties that were brought from sections having entirely different climatic conditions, and as they are not adapted to the South, the orchards have been unprofitable. Under any of the conditions mentioned, it may be possible to convert the orchard into a paying investment by top working the trees with buds or scions of better kinds, and it is this form of top working that is most widely known and practiced. Top working may be useful also in building up broken down tops of highly prized trees. It may be employed in grafting varieties into the tops of self-sterile trees to insure cross pollination. It may be practiced in re-forming the tops of trees like the peach, and it is especially useful in testing new varieties by bringing them into early bearing by top working them into bearing trees.

There are many varieties of orchard fruits desirable for commercial orchards or for domestic use that are lacking in hardiness or vigor. The trees may be susceptible to sun scald or to insect troubles, and are short-lived and unproductive when propagated in the usual manner. With a view to correcting these difficulties, orchards are sometimes planted with a single hardy, vigorous, straight-growing, long-lived variety. A year later, or as soon as the trees are well established and growing strongly, selected buds of the permanent varieties are grafted or budded in the body or branches, and the original tops are removed as soon as the new buds start into growth. This method of establishing an orchard by double working is growing in favor, especially with

apple growers who wish to provide some desirable quality through the stock not found in the body of the permanent variety, or to grow an orchard from buds taken from trees of superior merit.

TO LESSEN INJURY FROM SUN SCALD.

Sun scald is a climatic disease. It is especially serious on apples in the Mississippi Valley, the Ozarks, the Prairie and Northwestern States, and in the most northern apple regions of the East.

Pears, especially the Kieffer, cherries, plums, and occasionally peaches are injured also, but to a less extent. Sun scald is induced by warm spells of weather in the late winter and spring months, when the sun, shining on the south and west sides of a tree, causes the body and the larger branches to start into premature growth. If cold weather again sets in, the active parts of the body and sometimes of the large branches are killed. The bark and living tissues dry and adhere to the wood and crack open and separate from the body during the succeeding summer. The tree is finally weakened by bacteria and fungi, which cause the body to decay. It then either dies or is blown over.

The sun scald is most severe when there are violent alternations in temperature in the spring, accompanied by high winds, and it is especially disastrous when the ground is frozen so deeply that the tree can not absorb sufficient water to replace the moisture lost by evaporation.

Varieties differ in their susceptibility to sun scald, though the kinds apparently exempt in one locality may succumb to it in a more severe climate. Occasionally there may be winters when not only all of the young apple orchards but even some of the young forest trees in exposed places are affected. In New York and New England the Northern Spy, Roxbury *Russet*, Tolman, and Arctic are among the least susceptible, while Tompkins King, Twenty Ounce, Esopus, and Gravenstein are most often affected. In Ottawa, Canada, the Haas, McMahon, Wealthy, Oldenburg, and Gideon are seldom attacked, while nearly all of the New York and New England kinds are injured. Some of these varieties, however, like Northern Spy, have been grown successfully on these hardy, resistant stocks, where a hardy root was also provided. In the Mississippi Valley and the Ozarks the Ben Davis, Gano, Missouri *Pippin*, and Ralls are frequently attacked, while Limbertwig, Winesap, York Imperial, Grimes, Jonathan, and Greyhouse (*Hoopes*) are freer from it.

It is possible, therefore, to reduce the danger from sun scald by top working a susceptible sort on a variety that has proved more resistant to the disease. The selection of the stock depends on the behavior of the varieties in each locality. In addition to its resistance to the disease the stock should be equally vigorous in growth with the variety to be worked upon it.

Besides the selection of resistant stocks, the danger from sun scald can be reduced to a minimum by starting the top of the tree close to the ground, and by inclining the tree to the southwest. The branches thereby shade the body of the tree. It is possible also to prevent scald by the use of mechanical shading devices, such as lath, wire, or board screens, by wrapping the trunk with a flexible material like straw, to be removed in summer, or by inclosing the body in a box filled with earth.

TO MODIFY VIGOR.

There is a nice balance between the roots, the stem or body, and the top of the tree, and each part has a strong influence on the vigor of the other two. The slow-growing quince root, the doucin and paradise apple, and the mahaleb cherry and sand cherry reduce the normal vigor of the pears, the apples, the cherries, and the plums worked upon them, and make dwarfing or semidwarfing possible. The Northern Spy, Ben Davis, and Fallawater apples, all strong-growing varieties, develop an unusually vigorous root system in the stocks on which they are worked. In a similar way a strong-growing body invigorates both the top and root systems of the tree. The Jonathan, Wealthy, Oldenburg, Esopus, and Red Canada apples are thrifty but of slender growth, and all of them partake of the vigor of Northern Spy when top-worked on it.

In a similar manner the slender-growing cherries are made stronger when worked on the vigorous mazzard stocks. Pears are invigorated when worked on stronger growing bodies, and it is a common practice in some nurseries to double-work slender-growing varieties like Bosc, Winter Nelis, Barry, Wilder, and Danas Hovey on strong-growing bodies like Kieffer or Bartlett. Slender-growing plums, like Lincoln, are greatly strengthened when top-worked on the vigorous Marianna, and the Japanese chestnut is invigorated when worked on the American species.

Top working therefore becomes an important factor in making slender and weak-growing but otherwise desirable varieties of greater value. A striking example of the influence of a strong stock on a less vigorous variety is found in the Red Canada apple, which, under the name Steele's Red Winter, was extensively worked on seedling stocks in Wayne County, Mich., in the early history of apple growing there, sixty-five or seventy years ago. Under these conditions the variety was vigorous, prolific, a long keeper, and popular in the markets of the West. It was therefore propagated widely in the nurseries, but, when grown upon its own body, the trees were slow and weak in growth. For this reason the variety, when grown from nursery-propagated trees, was generally condemned, and was commercially obscured for many years. But in the orchards in which the variety

happened to be grafted on Northern Spy, or Tolman, it still retained the old-time vigor and productiveness of the early orchards that were top-worked on strong-growing seedlings. At the present time the variety is regaining its former prestige in Michigan, where its commercial value depends on top working it on a strong-growing variety.

TO MODIFY INSECT INJURIES.

The woolly aphis (*Schizoneura lanigera* Hausm.), known in foreign countries as the "American blight," attacks the roots, bodies, and tops of many varieties of apple. On the roots of nursery stock it is particularly disastrous, as it is most difficult to control in that position. On the trunk and top it is more easily subdued. All varieties are not equally attacked. In England first, and later in Australia, it was observed that the Winter Majetin was practically immune, and still later, when American apples were introduced into Australia, the Northern Spy was found resistant. Australian and some Western American nurserymen now offer lists of "blight-proof" stocks, on which the commercial varieties are propagated, and by their use the damage by the woolly aphis, which was a scourge to the apple industry of Australia, has been reduced to a minimum. The varieties are worked either upon the roots of the resistant stocks, or top-worked upon their own rooted trees.

METHODS OF OBTAINING A SELF-ROOTED TREE.

There are several practical ways of establishing a fruit tree on its own roots. Kieffer pears, Marianna plums, and most myrobolan plum seedlings, as well as some of the Japan plums, like Satsuma, may be grown from cuttings. With apples, scions may be whip-grafted on a piece of seedling root, and the scion planted at least 6 inches deep in strong, rather moist, but well-drained soil. In dry soils and in dry seasons the scions do not strike roots, but under favorable conditions the scion throws out a root system the first year. The original piece root may be removed, if it has thrown out roots, when the tree is taken from the nursery. Plums and pears may also be self-rooted by whip-grafting scions on piece roots.

In California the Northern Spy has been successfully self-rooted by inserting the scion by a veneer graft in the side of a whole seedling root a few inches above the crown. The root and scion are planted with the scion at least 6 inches in the ground. At the end of the season, after the scion has thrown out roots, the trees are lifted and the seedling root removed. The trees are then reset in the nursery, where they are cultivated until large enough for orchard planting.

One of the most successful methods has been followed in Iowa by Col. G. B. Brackett, Pomologist of the Department of Agriculture. It consists in inserting a scion of the desired variety on a piece or

whole root. The trees are grown in the nursery for two years, then taken up and laid in trenches. Each branch, after being slightly cut on the upper side, is bent up and well covered with earth, after the usual method of layering. The branches strike roots during the first season at the cut and bent portion, and in the fall or following spring they are removed from the parent tree and planted in the nursery, where they are cultivated until large enough for the orchard.

TO HASTEN FRUITFULNESS.

The insertion of buds in bearing trees hastens the fruitfulness of the variety. As Sorauer says, "by this insertion of a younger portion of a plant on an older stock the former can reap all the advantages of the more advanced age of the latter; it becomes, indeed, older itself." Apples and pears bear in two to five years earlier on scions in bearing trees than they do on nursery-propagated trees of the same varieties, and peaches, plums, and cherries one to three years sooner.

TO PERPETUATE DESIRABLE CHARACTERISTICS.

Fruit trees are generally propagated in nurseries from buds taken from vigorous nursery stock. Occasionally the propagator selects the buds from bearing trees, though the stand of nursery stock is smaller and the trees less vigorous. The nurseryman is primarily concerned in producing a block of vigorous, well-grown trees at the cheapest cost. The fruit grower, in the past, has not concerned himself with the individuality of the stock from which the nursery trees are propagated. His highest ideal is a big, well-grown tree, straight in body, well-branched, and well-rooted. The two ideals have, therefore, been harmonious.

But progressive fruit growers, and some nurserymen, are beginning to pay attention to the character of the parentage of nursery stock. The Baldwins and Elbertas in the same orchards differ in size, productiveness, color, form, keeping quality, and relative immunity from disease. In fact, no two trees of a variety are exactly alike, and among the individuals or buds of which the tree top is composed there is also more or less variation. Sometimes the fruit or foliage on a branch is so unlike the rest of the tree that a new variety is introduced by propagating from it. These strongly marked variations are known as "sports," and the Pierce grape, the Banks apple, and the Delaware (*Cannon's Early*) peach are sport varieties that appeared on branches of the Isabella, Gravenstein, and Mountain Rose, respectively.

It has been assumed that the smaller variations of a variety, such as more productive individual trees, larger or more highly colored fruit, or more vigorous foliage, are likewise transmissible. There is little doubt that permanent variations in a tree, no matter how small, may be transmitted by budding or grafting, but a practical difficulty lies in determining whether a variation is inherent, or incidental to the

food supply or other surroundings of the tree or branch. A well-fed, properly pruned, and carefully tilled and sprayed tree has larger foliage, is more vigorous, and produces better fruit than a neglected tree. But there is no reason to expect a transmission of these superior qualities in full degree, unless the descendants are surrounded with an equally favorable environment.

The stability of a variation can be determined only by comparing it for several years with other trees growing under similar conditions. If the tree or any of its branches persists in producing fruit or foliage of particular merit, or if the bearing habit is more regular, it is highly desirable to propagate the variety from such trees or branches. There have been no accurate or long-continued experiments in propagating fruits from trees of superior merit. The effort, however, to propagate only from the best is based upon sound principles of plant improvement, and is to be strongly encouraged.

Top working may therefore be used by the fruit grower to perpetuate desirable stable variations. The variety may be budded or grafted on a desirable stock after the trees are established in the orchard. Similar results may be brought about by the nurserymen by propagating only from specially selected buds, but the cost of growing the trees will be greater, and they will need to be sold at a higher price.

BEARING AGE OF YOUNG TOP-WORKED TREES.

Scions inserted on old trees bear at an early age, but it is uncertain whether the fruiting of scions grafted on a young tree is accelerated. Young trees, however, top-worked with buds from bearing trees, will bear a year or two earlier than trees propagated with buds from nursery stock, but it is uncertain how much of the influence is due to the top working or to the precocity inherited from the already productive parent. The Sutton orchard in Pl. XXVII, fig. 1, top-worked on Northern Spy stock, at 7 years old averaged a barrel and a half of apples to the tree. On the same farm, owned by Mr. George T. Powell, Ghent, N. Y., a Tompkins King orchard top-worked on Northern Spy stock, with buds from a tree of strong and regular bearing habit, averaged 3 barrels per tree in 1902 at 10 years old. Peach trees propagated from buds from bearing trees develop fruit buds the first year while in the nursery.

DETAILS OF TOP WORKING YOUNG TREES.

THE STOCK.

A single variety selected in accordance with the principles mentioned in the preceding paragraphs is desirable for a stock on which to top work the young orchard. Every consideration of permanency and uniformity discourages the use of miscellaneous seedling stocks. Every seedling is a distinct variety, and no two are alike in hardiness, vigor, immunity from climatic or other difficulties, or in longevity.

In severe climates the stock should be established on vigorous, hardy roots; but in other localities the greatest uniformity may be expected from well-grown self-rooted trees, or from trees propagated on specially selected vigorous seedling roots. Where a check to the growth is not especially sought, the stock should at least equal in vigor the variety worked upon it, or the scion will eventually overgrow the stock.

In planting, the stock should conform to the usual age for setting the fruit. The tops may be budded with the permanent variety later in the same season if the trees are growing vigorously, or they may be grafted or budded during the second season. It is advisable to top work the orchard as early as possible after it is well established, as the shock to the tree by removing the original top and the loss in energy expended in the growth of the top increases with its age.

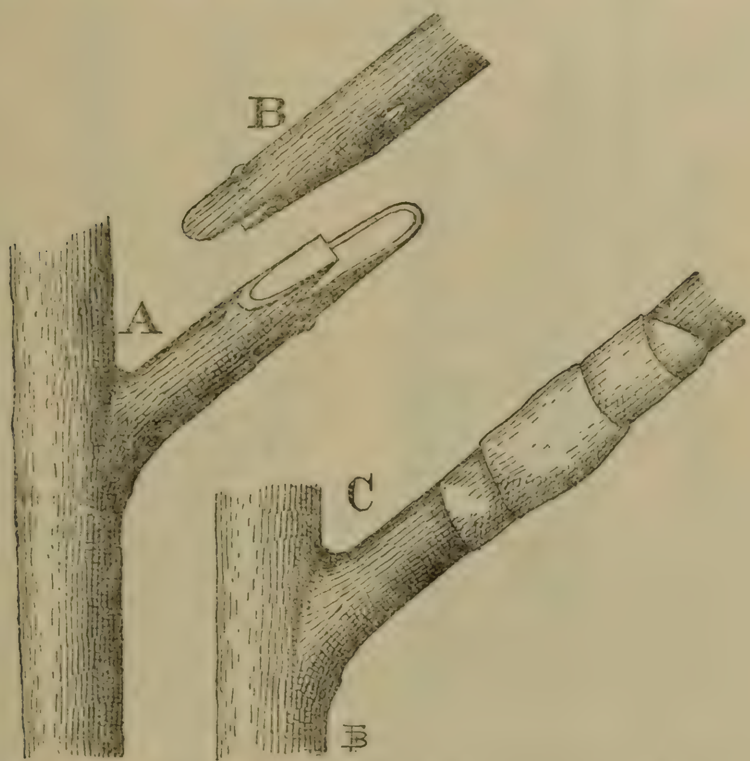

FIG. 15.—Tongue or whip grafting: *A*, stock prepared; *B*, scion prepared; *C*, stock and scion united and wrapped.

GRAFTING.

The young orchard may either be grafted or budded, or grafting and budding may be used in combination on the same tree. The trees may be worked on the body or branches, or on both in combination.

Grafting is the process of inserting a scion on a stock so that the growing parts of both are in contact. The operation is performed in the spring just as the foliage is pushing forth, though it may be done either a little earlier or later.

There are many kinds of grafting, but with young trees in which the branches are not over three-eighths of an inch in diameter, the

tongue or whip graft is most common. In making it the scion and stock are cut diagonally, after which a vertical cut is made in the cut surface of each. The tongue of the scion and the cleft in the stock are then joined together and the parts are held firmly with a bandage of waxed string or cloth. The details of the operation are shown in fig. 15. The cleft graft is used for larger branches, and the operations are explained in fig. 16 and in greater detail later on in this paper.

In branch grafting the scions are inserted in three to five branches well distributed over the trunk, in accordance with the grower's ideal for a top. A branch-grafted tree, with the scions just pushing forth their leaves, is shown in fig. 17. A similar tree, three months later,

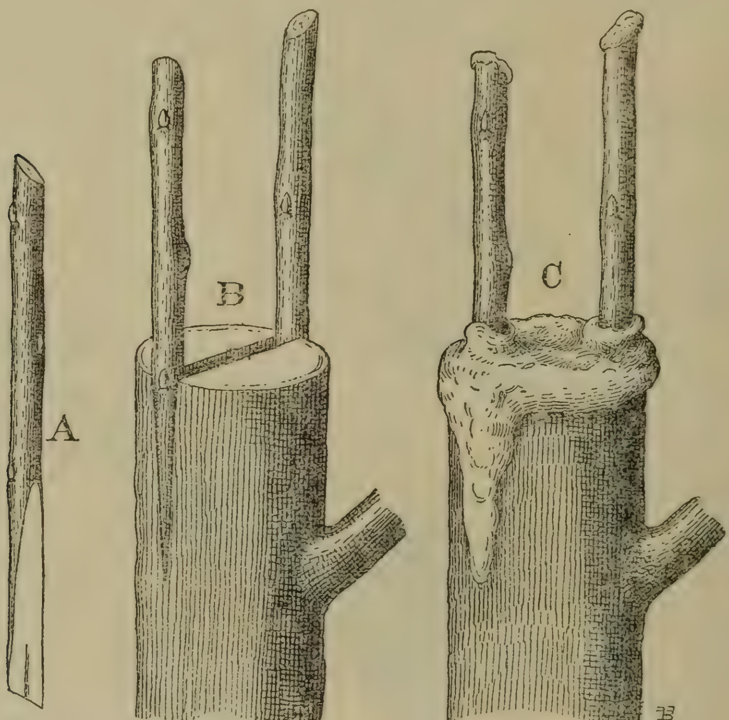

FIG. 16.—Cleft grafting: *A*, scion; *B*, scions inserted in cleft; *C*, stub and scions waxed.

is shown in Pl. XXIV, fig. 1. A Sutton apple orchard, 7 years old, branch-grafted on Northern Spy, is shown in Pl. XXVII, fig. 1.

The branch-grafted tree develops into a shapely form if the scions live, but the death of one or more of the scions destroys the balance of the top. This may be corrected by inserting a June bud on the same branch or by budding it in the fall, or by regrafting it the following spring. It is a difficult matter, however, to restore the proportions of a top where the scions are of different ages.

In some sections the larvæ of bud moths play havoc with the scions just as they are starting into growth, and make the establishment of a well-formed orchard a most difficult undertaking. The trouble may be largely overcome by inserting the buds in the body of the tree

instead of the branches, when any one of the buds alone may become a leader and form a top. (See figs. 18 and 19.)

A single scion is sometimes inserted in the body of the tree, and although it is often successful the method is objectionable, as the stock alone remains if the scion perishes.

Fig. 17.—Branch-grafted tree.

BUDDING.

Budding is the insertion of a bud attached to a piece of bark upon the growing part of the stock. There are many kinds of budding, but the shield bud, the details of which are shown in fig. 20, is usually employed with the more common fruits. The operation may be performed whenever the bark will slip, which occurs just as growth is starting, again in early summer, and in late summer and early fall. In the North budding is usually done from the last of July until the first or middle of September, with mature buds of the season's growth. The buds remain dormant until the next spring. In the South, June budding is also practiced with immature buds, which start into growth the same season. Budding is sometimes done in early spring with dormant buds taken in the winter and retarded in a cool place.

Fig. 18.—Body-budded tree.

In top working young trees the budding may be done in the branches, on the body, or in both in combination. The branches are selected in the same manner as outlined for grafting, though a bud may be inserted in the body of the tree if no branch is suitably located. Fig. 21 shows a tree with buds in three branches and a bud inserted in the body to balance the top. The buds should be inserted on the branches several inches from the body of the tree, so that the same branch may be rebudded or grafted if the original bud perishes. With spring budding, a second bud may be inserted in June if the first

bud dies, and a bud may be inserted in the fall if a June bud dies. A graft may be set or a bud inserted in the spring on a branch in which a fall bud dies. An August branch-budded tree is shown in fig. 22. Three of the buds on the branches lettered *B* in the illustration failed to grow, and the scions which are just pushing out were inserted in the spring. The bud lettered *A* was the only one that survived. A branch-budded tree with a top three years old is shown in Pl. XXIV, fig. 2.

FIG. 19.—Body-budded tree, with two buds killed by bud-moth larvæ.

One of the most satisfactory methods of budding young trees is to insert the buds in the body. An ideal top can be formed, as the buds can usually be placed in the most desirable positions on the body. A striking advantage also lies in the capacity of any single bud to form a leader and make a top in case of the death of the remaining buds. A body-budded tree is shown in fig. 18, and a similar tree three years later in Pl. XXV, fig. 1. A tree in which two of the buds have been killed with bud-moth larvæ is shown in fig. 19, and a similar tree with the top formed from a single bud in Pl. XXV, fig. 2.

Budding is usually more satisfactory than grafting. The operation is more simple, the wound heals more quickly, and the form of the tree can be regulated to better advantage by inserting the buds on the body, but the most satisfactory results follow the adoption of both branch and body budding on the same tree when one is needed to supplement the other.

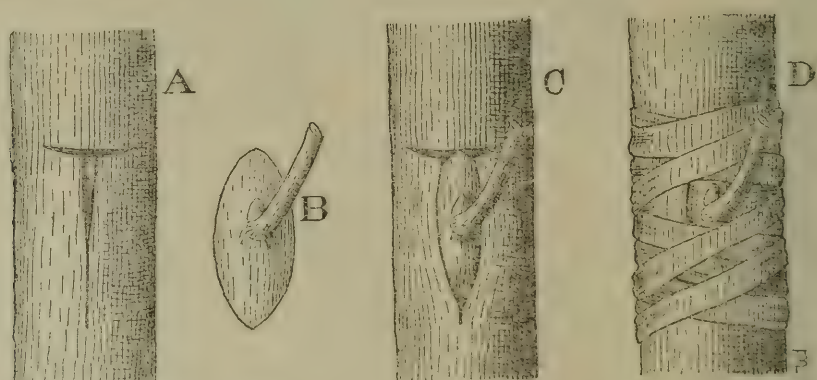

FIG. 20.—Shield budding: *A*, matrix; *B*, shield bud; *C*, bud inserted in matrix; *D*, bud tied.

CARE OF THE TOP-WORKED YOUNG ORCHARD.

The spring grafted or the spring or fall budded tree should have the remaining branches removed as soon as the scions or buds start into growth. The branch should be cut off an inch or two beyond the bud, and a month or two later, when the danger to the new shoot from blowing out is lessened, it should be cut close to the shoot, so that the

FIG. 1.—STAYMAN WINESAP, BRANCH WHIP-GRAFTED ON BEN DAVIS. NEW GROWTH 3 MONTHS OLD.

FIG. 2.—MISSOURI PIPPIN, BRANCH-BUDDED ON BEN DAVIS. TOP 3 YEARS OLD.

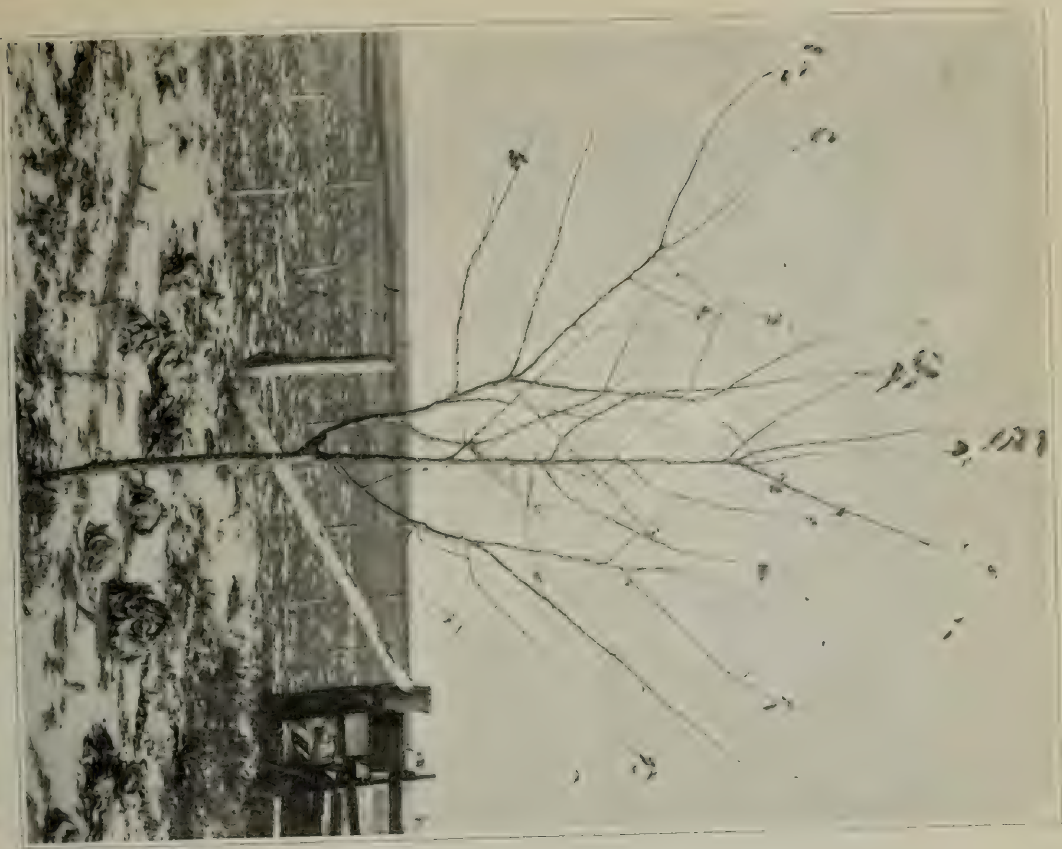

FIG. 1.—STAYMAN WINESAP, BODY-BUDDED ON BEN DAVIS. TOP 3 YEARS OLD, FORMED FROM THREE BUDS.

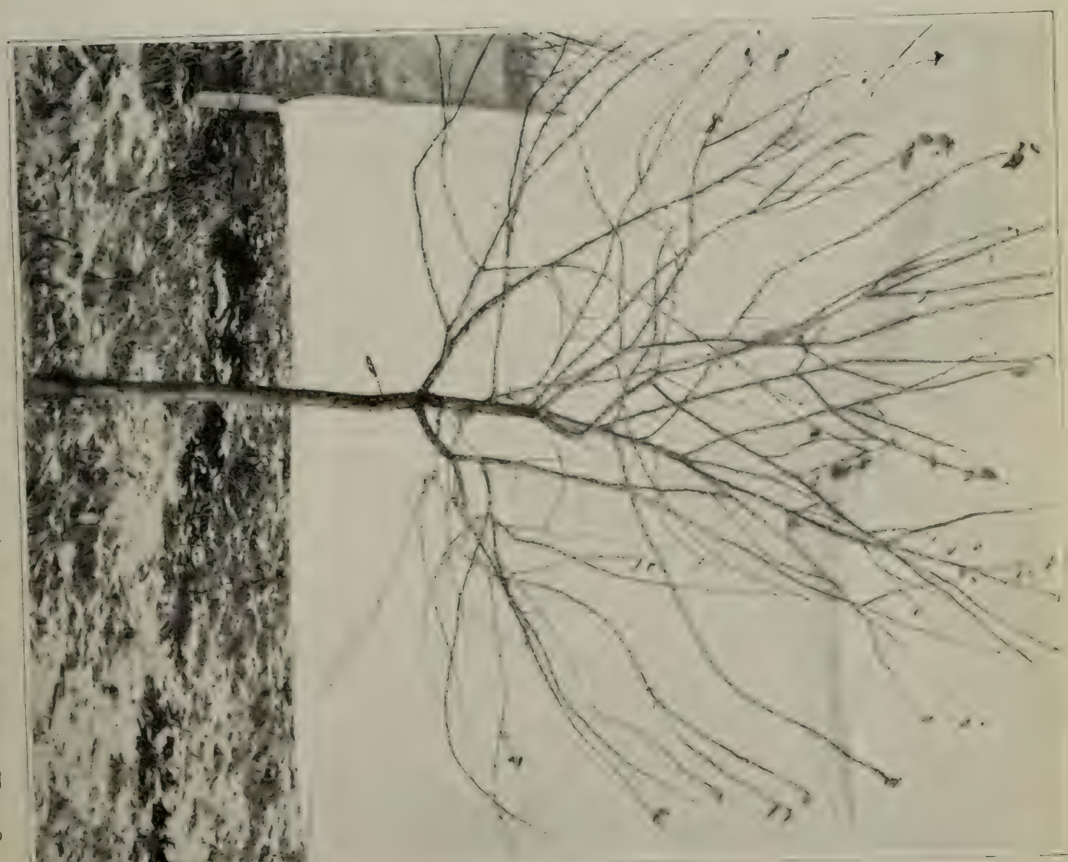

FIG. 2.—STAYMAN WINESAP, BODY-BUDDED ON BEN DAVIS. TOP 3 YEARS OLD, FORMED FROM ONE BUD.

end of the branch may heal over during the season. It is not always advisable to remove the entire top from a June-budded tree as soon as growth starts, as the buds may grow too vigorously and be blown out. If the water shoots that arise on the body and branches are left until the next spring, the growth of the buds will be retarded.

The top-worked tree needs the most careful attention during the first season. Except in June-budded trees, the water sprouts should be removed three or four times to prevent dwarfing or smothering the scions. During the latter part of July or early in August the rank-growing branches may be headed in to stock them up, and the side branches may need pruning to strengthen them and to give the top a desirable form. After the first year, the tops are treated like any other tree of the same age.

FIG. 21.—Branch-budded and body-budded tree.

TOP WORKING BEARING APPLE TREES.

There are many apple orchards not over 25 to 30 years of age in good, healthy condition that might be top-worked with better varieties. It is not profitable to top work larger trees, as the large branches that need removing do not heal over readily, and the tree usually dies from decay. It is also too expensive to set the scions in the large trees. An apple tree may be remodeled in three or four years by inserting scions in part of the branches each successive season. Branches larger than $2\frac{1}{2}$ inches in diameter should not be grafted, as they do not heal over, and are also more susceptible to sun scald. The operator should endeavor to maintain the original form of the tree. The branches at the top are cut off rather close to the body, and at a greater distance as the base is approached. The large branches need shading while the remodeling is in process. This may be provided by distributing the scions evenly throughout the tree each year and by leaving some of the older branches. Only a few branches should be grafted in one place in a single year, as the exposed stubs, especially in the Southern States, are usually scalded. It is always advisable to graft a larger number of branches than necessary for the final top. The scions shade the branches and may be removed as they overcrowd.

A top-worked tree requires close attention if the operation, which is harsh at the best, is to be successful. All large wounds should be painted with red lead to prevent the entrance of fungi and bacteria. The scions should be watched to prevent their dwarfing and smothering by overhanging branches. Water sprouts, which appear in abundance, need removing in June. Every endeavor should be used to re-cover the tree as quickly as possible, and to protect it from injury while the operation is in progress. A tree 25 years of age partly remodeled is shown in Pl. XXVI, fig. 1, and a tree with the entire top replaced with scions in Pl. XXVI, fig. 2.

FIG. 22.—Branch-budded and grafted tree. Buds inserted in August. Bud on *A* lived. Buds on *B*, *B*, and *B* died, and these branches were grafted the following spring.

The grafting is done in the spring with dormant scions, two of which are inserted in a horizontal position in each stub. The stub and the end of each scion are then carefully waxed. The operation may be understood by reference to fig. 16.

TOP WORKING BEARING PEACH TREES.

There has been a large development in the peach growing business in the last decade. With the rapid growth of the industry many varieties have been planted in large quantities that are undesirable for commercial purposes or ill-adapted to the regions in which they are located. There are also many orchards more than 10 years old, with trees still vigorous, but of varieties that are no longer equal to the newer commercial sorts. To sacrifice the orchards by cutting them out means a loss of labor and capital already invested, but to leave the trees unchanged continues an unproductive investment. It is possible to top-bud these orchards with better varieties, and it may be desirable from the commercial standpoint to do so if the trees have been given good care, as new tops may be formed that will produce good crops in three or four years.

FIG. 1.—APPLE TREE, TOP-WORKED, 2 YEARS OLD. ORIGINAL TOP PARTLY REMOVED.

FIG. 2.—APPLE TREE, TOP-WORKED, 4 YEARS OLD. ORIGINAL TOP ENTIRELY REMOVED.

FIG. 1.—SUTTON APPLE, TOP-WORKED ON NORTHERN SPY.

FIG. 2.—TOP-BUDDED PEACH TREE. STOCK 9 YEARS OLD; TOP 3 YEARS OLD.

The budding may be done either in June or in the fall, the season depending on the locality and the convenience of the grower. The buds may be inserted on the main branches if the diameter of the latter within 6 or 8 inches of the trunk is not over 1½ inches. On larger trees it is not advisable to bud the main branches, but new shoots in which the buds can be inserted may be provided near the trunk of the tree by cutting off the main branches within 1½ to 2 feet of the body, and by thoroughly cultivating the soil after the heads are removed.

In preparing the tree for fall budding it is often possible to pick the fruit, then cut back the top, and insert the buds in three to five of the main branches near the trunk, the distribution of the buds having regard for the form of the future top. In large trees the cutting back is done the preceding winter or spring to provide the new shoots for budding. In the South, however, where fruit is harvested earlier in the season, it is possible to take the crop, remove the top, and then by frequent cultivation provide new shoots on the larger branches that can be budded in August of the same year.

As soon as the new buds start into growth the old top should be entirely removed and the branches bearing the buds cut back close to the bud. The new shoots that grow on the old branches should be kept off, and the new head formed in accordance with the grower's ideal for a top. It may be advisable to head in the shoots of the new top during the first summer to stock them up and prevent long, slender, weak branches. The ends of the old branches should be painted with red lead to prevent the entrance of fungi and bacteria which cause their decay. If care is exercised in all of the operations, the new top may bear profitable crops for many years.

A tree 10 years of age, with a new top 3 years old, is shown in Pl. XXVII, fig. 2. This tree should bear a good crop a year later.

GRAFTING MATERIALS.

There are many kinds of grafting wax, but one made by melting 1 pound of tallow, 2 pounds of beeswax, and 4 pounds of resin is satisfactory for open-air work. The melted liquid is poured into cold water, when it hardens. As soon as it is cool it is pulled like molasses candy until it is light colored. The wax may be kept indefinitely by wrapping it in oiled paper and putting it in water.

In tying whip grafts, waxed string is often used for root work, and for the branches either waxed string or strips of waxed cloth. The waxed string may be made by dropping balls of No. 18 knitting cotton into melted wax. The wax quickly penetrates the ball. The waxed strips may be made by dropping a ball of old cotton cloth cut into

narrow strips into melted wax, or the wax may be spread on the cloth, after which it can be cut or torn into strips of the desired sizes.

In budding, raffia is generally used for tying. The raffia can be purchased at about 20 cents a pound. It should be soaked in water for a few hours before using, when it may be cut into strips of the desired length.

THE EDUCATIONAL VALUE OF LIVE-STOCK EXHIBITIONS.

By George M. Rommel,

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INTRODUCTION.

It is said that the late M. W. Dunham received the inspiration which directed his energies into the field of horse breeding at an Illinois fair in the latter sixties. From the interest aroused by the exhibition of a Percheron stallion, he was led to make a journey to France to study and purchase these horses on their native soil, and the influence of this apparently insignificant event molded the man's after life, and was of infinite value to the Percheron horse in the United States.

The possibilities of live-stock exhibitions from an educational standpoint can hardly be estimated, and they can be discussed here only in a general way. The career of Mr. Dunham stands out prominently in the annals of American agriculture, and we can, by this one notable instance, arrive at a measurable appreciation of the educational value of these exhibitions; but no man can tell how much the rank and file of breeders and stock raisers may have been inspired by such influences, nor can any statistician estimate the value to the country of the work of these men. That they have an exceedingly strong hold on the attention of the public is unquestioned. Every year hundreds of thousands of dollars are expended for premiums and the running expenses of the shows and millions of people attend them. Even at county fairs, premiums to the amount of $5,000 or more are not infrequently offered, and the daily attendance is often from 15,000 to 20,000, with a frequent total of 50,000. At the larger exhibitions, such as the great State and National live-stock shows and the great horse shows, the amounts offered for premiums vary from $20,000 to $40,000 and the total attendance from 50,000 to 250,000. Although the pleasure-seeking element is always in evidence, yet there is a constantly growing sentiment that directs attention to such shows as valuable educational forces. This enlarging estimate of their value to the public is shown by the act of the chief executive of a "corn belt" State, who, in an official proclamation, urged the farmers of the Commonwealth to attend the International Exposition of 1902, and the very large attendance of townspeople shows that persons of all ranks recognize the necessity of being informed concerning one of the greatest industries of the nation.

VALUE TO THE EXHIBITOR.

A carefully classified and well-conducted live-stock show will provide instruction not only for the spectators—almost equally important are the lessons taught the exhibitor himself. The public does not generally realize the fact that exhibitors usually add to their knowledge of animal form and management at each show to which they bring their animals. Most people think that a man who brings an animal into a show ring is beyond the necessity of acquiring knowledge of the selection and management of his animals; but, while the best authorities on these subjects are almost always among the exhibitors, the ranks of showmen frequently include some inexperience and mediocrity.

The educational value of a show to an exhibitor may be in fitting his animals for show, in competition in the show ring, in the interchange of views with other breeders, and in an enlarged, useful acquaintance; and the exhibitor may also learn much by a study of the requirements of the market which he seeks to supply.

FITTING FOR SHOWS.

When a man contemplates entering the show ring, whether in his county exhibit or at his State fair, he will be wise to send his stock in good condition. At some shows this requires that an animal be fattened almost to the danger point. It is necessary that meat-bearing animals should give good indications of their fitness for the block, and it is always more pleasing to look at a horse that has been well fed than at one that is thin; besides, fat "covers a multitude of sins," even in a horse. That the requirements of a show season are extremely severe on the animals submitted to it, solely owing to the stuffing process that must be undergone, no one will deny. Many very capable breeders refuse to show on this account, placing their entire reliance on newspaper advertising. However, while some animals have been ruined for breeding purposes by this excessive feeding, many have come through unscathed by reason of inherent worth and good management.

In bringing his cattle to this prime condition (prime from the butcher's standpoint), the exhibitor has a constant opportunity for the study of the development of animal form and condition. He must calculate carefully in order to bring the herd "to edge" just at the right time, otherwise they will be "faulted," as in poor condition or overdone. He must force them steadily or they will become rough, uneven, patchy, and, as this condition is very closely dependent on the quality of the animals, it follows that long before the fitting begins the breeder must have selected the individuals in his herd that would best respond to the fitting with least danger of serious injury. As the fitting advances it will be observed whether the original judgment was correct—whether the animal filled out here or became a trifle rough

there. Much is thus learned regarding the development of the animal during growth and fattening, and the breeder learns to select animals that will develop to the best advantage, which is, next to selection in mating, the highest achievement of his art.

COMPETITION IN THE SHOW RING.

When the show ring is reached the exhibitor, if a beginner, first comes into contact with two very important factors in this educational scheme. One is the competitor and the other the judge. He thus has an opportunity to compare the results of his own ideas with those of others. The best opportunity a man has to learn the weak points of animals is at such a time, especially if he is defeated, and he can return home with these ideas and those of his competitors and the judge to help him.

THE STUDY OF MARKETS.

At the larger shows the exhibitor comes in contact with the men who control the market, and an interchange of ideas is therefore possible, resulting in closer connection between these two forces of production. The requirements of the market must be understood by the breeder before he can hope for success in his work, and here he can gain this knowledge. The highly finished harness and saddle horse in the arena gives the breeder of horses higher ideals; the exhibition of dressed carcasses at a fat-stock show is always a drawing card, and is a feature in which the exhibitor should be deeply concerned. It shows him the ideal carcass of the packer's mind, and with it before him he can study to reconcile his own ideal of a fat animal on foot, a task for him yet to be accomplished. The exhibition of packing-house products forms a very useful adjunct to the dressed-carcass show, and is now a feature of the show season.

VALUE TO THE SPECTATOR.

The success of a show as a show depends mainly on a creditable exhibit of animals. Its success as a financial undertaking depends on the public, and, no matter how good its exhibits, no exhibition can last long without a good revenue from admissions, unless it has the power of the State or of a very strong and liberal corporation behind it.

People attend shows primarily to see things, and these are usually the animals exhibited. At the American Royal and the International the animals are practically the sole inducement for attendance.

Of the vast throngs which attend live-stock exhibitions, not all are there to amuse themselves—thousands of people make use of the opportunity to study the animals in the ring. These persons are in the live-stock business; they must have instruction in methods and ideals, and they must keep in touch with the productions of the leading breeders. In addition to those who have already a more or less

complete knowledge of animals, are the young men on whom the example of an outstanding winner may be forcefully impressed.

The spectator finds profit, educationally, at an exhibition of live stock principally in three ways: (1) From the ideals presented and the inspiration given; (2) in direct instruction; and, (3) in the lessons conveyed on the necessity of pure breeding.

IDEALS AND INSPIRATION.

At many of the exhibitions is to be seen the very cream of animal production. Even at his county fair the farmer may learn much by a study of the best products of his neighbors; at his State fairs he sees stock of still better breeding and in higher condition, while at a show of National scope he will find positive inspiration. The pick of the smaller shows—those that have been selected by a rigid judgment as worthy to compete with the best in the land—are there, pitted against each other for the final contest, and many breeders who confine their exhibits to the largest shows here submit their work to the same inspection. The student, farmer, and breeder may here see the most perfect of form and quality—animals brought to the keenest edge of condition, on which no expense has been spared to bring out all there is in them. The real inspiration received here does not die out with the last flutter of a blue ribbon.

DIRECT INSTRUCTION.

Each live-stock exhibition gives many opportunities for direct instruction, especially when it is conducted on a small scale. A feature of many county fairs has come to be a talk by the judge on the relative merits of some of the more prominent animals, and it is very frequent at the large stock shows to see a judge discussing a prize winner with a little party of spectators. These discussions are often of the greatest benefit, for it does not always happen that the spectator at the ring side is in a position to determine accurately the relative merits of the animals in the ring, as there are nearly always a number of points that show only on close inspection. A discussion by a competent and fair-minded judge almost always clears away objections, and results in good feeling—a very desirable sentiment at a ring side. When occasion permits, a time set apart for formal discussion of the requirements of different breeds or of the market proves to be one of the most valuable features of the show. Such instruction will crystallize the ideas already gained by observation, and will bring out many indistinct and mooted points whose discussion leads to fruitful results.

A leading educational feature that can not be overlooked in a discussion of live-stock expositions is the meeting of students for contest in stock judging. The wonderful growth of instruction in animal husbandry in the colleges has had a natural outlet in such trials of

strength. Inaugurated at the show of the Trans-Mississippi Exposition in 1898, students in these contests have received recognition by the colleges, by the press, by commission men, by stock yards companies, by breeders' associations, and by the public. These contests bid fair to become permanent adjuncts of agricultural college work. In such a contest, a student will find out more about himself and about his fund of knowledge than he will in several months' instruction; he concentrates his opinions, reviews them, strengthens and fortifies those that are correct, discards those that are misleading and wrong; he learns self-possession; develops the faculty of observation and keenness of vision at a wonderfully rapid rate, and, besides, learns to express himself correctly.[a]

It may well be said that this rapid development of the educational element in animal husbandry is as much a feature of the industry at the opening of the twentieth century as the rapid evolution of breeds was characteristic of the opening of the nineteenth century. It is certainly true that live-stock exhibitions were very common in the early days, and doubtless our grandfathers discussed all phases of the shows with warmth and vigor; but this idea that there is a real field here for education is of recent development, and the systematic training of young men for a foundation in the principles of stock judging has had practical and successful application within the past twelve years only.

THE LESSON OF PURE BREEDING.

A man may go to a show and receive inspiration and instruction, yet go home none the better for his visit if he does not carry with him the great lesson of all such exhibitions, namely, that the champions were the result of a systematic plan of breeding, not accidents of heredity.

The value of pure breeding in itself is first impressed on the spectator's mind. The live stock on exhibition are not the progeny of grade males, and all breeding animals should be registered or immediately eligible to registry. This is the logical outcome of years of experience. An animal can not be trusted to produce progeny similar in form to itself unless it is from a long line of ancestors that have been bred to an accepted standard. In producing animals for the markets the male should always be pure bred. The motive for the use of a grade sire is usually economy in the purchase price, and there is a tradition that a grade is more easily kept than a pure bred; but this is not borne out by careful observation. The lesson of the show

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[a] The liberality of Mr. John Clay, jr., and Mr. A. H. Sanders have recently made possible the participation in these contests of boys from the farm who have been denied the advantages of college instruction. The results of such efforts should be of the greatest value.

points out on every hand the overwhelming importance of the use of pure-bred sires.

In a first-prize "exhibitors' herd" may be seen the results of years of work along definite lines. The successful breeders do not switch from one breed to another, nor work inconsistently. The Messrs. Tomkins (father and son), Thomas Bates, Amos Cruikshank, Hugh Watson, and almost every breeder whose work has been of original and lasting value, have devoted the better part of a lifetime to their chosen work. If the American farmer has a fault that can compare with his extravagant use of feed, it is his shiftiness in breeding his live stock. This is true of every kind of stock, from horses to chickens. Our horse stock is most outrageously mixed. A man serenely breeds a draft mare to a trotting stallion, or perhaps the reverse (which is better); he thinks nothing of having one mare on the place "one-fourth Hambletonian and three-fourths Norman" that he is going to breed to a Clyde horse on a neighboring farm, and another whose breeding he can not vouch for, but which he will breed to a trotter that has a local reputation. A similar system is repeatedly met with among cattle, sheep, and hogs, and some of the flocks of amateur poultry raisers are beyond description.

Live-stock exhibitions serve to intensify the utility of proper selection in breeding. The spectator sees there animals whose breeding for generations back has been planned by one man, who has an ideal in mind, and is becoming more capable as the years go by. He notices that the herd of such a man contains animals very much alike, and inquiry shows that they have been bred carefully along well-defined lines, and within pretty well-defined family lines, but he will also see that what inbreeding has been practiced was used judiciously. On the other hand, there may be a herd that does not show the uniformity of this one, for, although it is pure bred and contains some prize winners, it is "spotty" in breeding and lacks the uniformity of a herd bred consistently and systematically.

When the spectator thinks of the stock at home—cross bred, mixed bred, and scrubs, a grade bull in the pasture—this great lesson of the value of pure breeding is more emphatically enforced, and the mind is again inspired to better work. No one forgets his first visit to a great stock show. The hugeness of everything—the size of the cattle, the bigness of the hogs, the spread of back, loin, and quarters of a mutton sheep and the efforts to make this spread as great as possible, the big horses—these things give rise to the first impressions he receives. If one is at all a judge of stock it does not take long to begin looking for quality and constitution and then for breed type. When a man begins to realize that all this magnificence is the result of pure breeding, he is learning one of the greatest lessons of the show.

SOME OF THE PRINCIPAL INSECT ENEMIES OF CONIFEROUS FORESTS IN THE UNITED STATES.

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INTRODUCTION.

Within recent years the writer has made a preliminary survey of the principal forest regions of the United States, from southeastern Florida to northwestern Washington, from northern Maine to eastern Texas, and in the middle Appalachian region, the middle Rockies, and the Pacific slope, for the purpose of obtaining information relating to the principal enemies of the forests, the location and extent of areas of greatest depredation, and the possibilities of preventing losses.

It was found that among the many hundreds of insect enemies of forest trees observed and collected there are a few species which are of primary importance in their relation to widespread devastations. Indeed, it would seem that the most important enemies of coniferous forests in this country are restricted to a few species of a single genus of beetles. This genus was described by Erichson, of Berlin, Germany, in 1836, under the name Dendroctonus, which means "killer of trees." It is represented in Europe by only a single species, but in this country some eighteen species have been recognized. With few exceptions, they are all that the generic name implies, and the greater number are even more, for they are real devastators of forests.

One of the species of this genus, known as the spruce-destroying beetle, has been, according to published data, a menace to the Northern spruce forests during the past eighty years. Its work has from time to time taken the character of an invasion and destroyed many millions of dollars' worth of the best spruce timber in different sections, from New Brunswick to New York.

The destructive pine bark-beetle is another species which threatened the entire destruction of the pine and spruce of Virginia and West Virginia between 1890 and 1892, and before its ravages were checked it killed many millions of the best pine and spruce forest and shade trees in the two States.

The pine-destroying beetle of the Black Hills has been, within the past six or eight years, devastating the forests of the Black Hills Reserve in South Dakota. It has already killed some 600 million

feet of timber, and is threatening a like fate to the remainder. This involves not only the destruction of the timber, but also that of the great mining and other industries of that region which are dependent on the timber supply.

The records and available evidence show that these three species alone have demonstrated their ability, under specially favorable conditions, to devastate the pine and spruce forests of the entire country. Therefore they are worthy of general attention and the most detailed investigation.

The facts already determined by study of the insects and their work indicate plainly that most of the forests of the country which are available for the application of improved forest methods and systematic working plans can usually be protected from this and like dangerous enemies at a slight cost.

The prime requisites for success in combating this class of pests are: First, the prompt recognition of the commencement of a trouble; second, the determination of the insect causing it; and, third, the prompt application of the proper treatment before the depredations have spread like a conflagration.

It is the object of this paper to call attention to what are believed to be the worst insect enemies of coniferous forests, also to some of the characters of the insects and their work, by which they may be readily recognized, and to the peculiar methods of control applicable to each.

THE SPRUCE-DESTROYING BEETLE.

(*Dendroctonus piceaperda* Hopk.)

This insect was perhaps the first of its class to claim attention in this country, owing to its destructive invasions of the spruce forests of New England and New York from 1818 to 1900, as described by Peck, Hough, Packard, Fisk, and the present writer.

DESCRIPTION OF THE VARIOUS STAGES OF THE BEETLE.

THE ADULT (fig. 23, *a*) is a reddish brown to black beetle, varying in length from three-sixteenths to four-sixteenths of an inch (4.7 to 6.0 mm.). The body is sparsely clothed with rather long hairs, and has other distinctive characters, as shown in a general way in the illustrations.

THE EGG is a small, pearly-white object, scarcely to be distinguished from those of other bark beetles of the same size.

THE LARVA (fig. 23, *b*) when first hatched is a minute white grub, which increases in size until it is slightly longer than the beetle, and is distinguished from other larvæ of the same class by a dark yellowish brown space on the upper surface of each of the last two abdominal segments.

WORK OF THE SPRUCE-DESTROYING BEETLE.

[Primary or egg galleries in inner portion of spruce bark, from dead tree. From photograph.]

THE PUPA (fig. 23, *c*) is nearly white, of the same size and somewhat the same form as the adult, but without free legs and wings, and is found in oblong cavities in the bark of trees where the broods develop.

HABITS OF THE ADULT AND LARVA.

Many pairs of beetles make a simultaneous attack on the lower half of the main trunk of medium-sized to large trees. They bore through the outer bark to the inner living portion, and through the inner layers of the latter they excavate long, irregular longitudinal galleries (Pl. XXVIII), and along the sides of these, at irregular intervals, numerous eggs are closely placed. The eggs soon hatch, and the larvæ at once commence to feed on the inner bark, and as they increase in size extend and enlarge their food burrows in a general transverse but irregular course away from the mother galleries (fig. 24, *d*). When these young or larval forms are full grown each excavates a cavity or cell at the end of its burrow and next to the outer corky bark.

FIG. 23.—Spruce-destroying beetle: *a*, dorsal view of adult beetle; *b*, side view of larva; *c*, dorsal view of pupa—all greatly enlarged; *d*, natural size of beetle. (Original.)

The period of development from the egg to the matured larva varies from two or three to nine or ten months, depending upon the condition of the weather during growth. With the first hatched larvæ in June the period will be shorter, while those hatched later in the summer will not complete their growth until the next spring. Under the climatic conditions prevailing in northwestern Maine, eggs deposited about June 19 will develop to pupæ by September 1, and to adults by October 4, but will not emerge until the next spring. It appears that activity ceases about the middle of October, when all stages of the insect may occur in the bark of infested trees, where they, with probable exceptions of the eggs and pupæ, remain until about the first week in June. Activity then commences, the matured larvæ soon change to pupæ, and by the middle of June those that pass the winter in the adult stage emerge and commence to excavate galleries and deposit eggs. The adults, from hibernating larvæ of different stages, develop and continue to emerge from the last of June until the last of August. The eggs deposited by the late-developing beetles produce larvæ which do not complete their development until July or August of the next year, and consequently the period from the time the first galleries are excavated and eggs deposited until the broods of adults emerge is about

one year. Under different conditions of latitude and altitude these dates and periods will be different.

HOW THE TREES ARE KILLED.—The numerous primary or egg galleries penetrate the most vital parts of the tree (the cambium), where the principal activity involved in new growth takes place. This causes at once a loss of vitality and a weakened resistance. The exca-

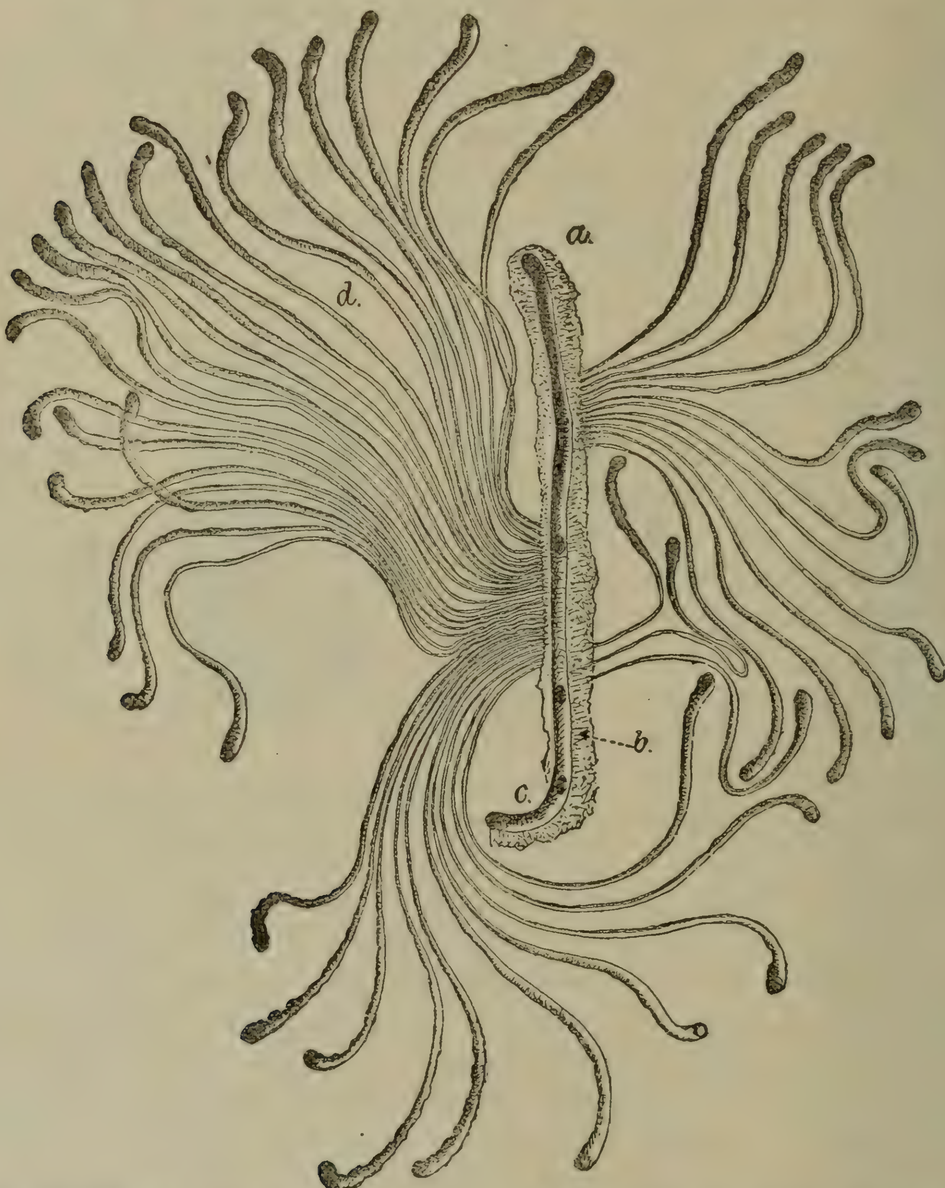


FIG. 24.—Work of the spruce-destroying beetle: *a*, primary gallery; *b*, borings packed in side; *c*, entrance and central burrow through the packed borings; *d*, larval mines—note how the eggs are grouped on the sides. (Original.)

vation of the primary galleries is immediately followed by the transverse burrowing operations of the young broods, which rapidly complete the destruction of all remaining life in the bark. Thus, the tree is completely and effectually girdled. This is followed some months later by the dying and falling of the leaves and the complete death of all parts of the tree. By the time, and even before, the leaves die and

fall the new broods of beetles emerge from the bark and migrate in swarms to other living trees, which in a like manner are attacked and killed.

AREA INVADED.—The species extends from New Brunswick to New York and westward to the Black Hills of South Dakota; also northward into Canada. It attacks and kills the Red, Black, and White spruces, but only the larger trees. The amount of timber killed by it, as indicated by published accounts and the writer's observations, has been very great; certainly within the past half century several billions of feet of timber have been thus destroyed.

METHODS OF PREVENTING LOSSES FROM FUTURE DEPREDATIONS.

A series of experiments conducted during the summer of 1900 and again in 1902 resulted in the determination of some important facts

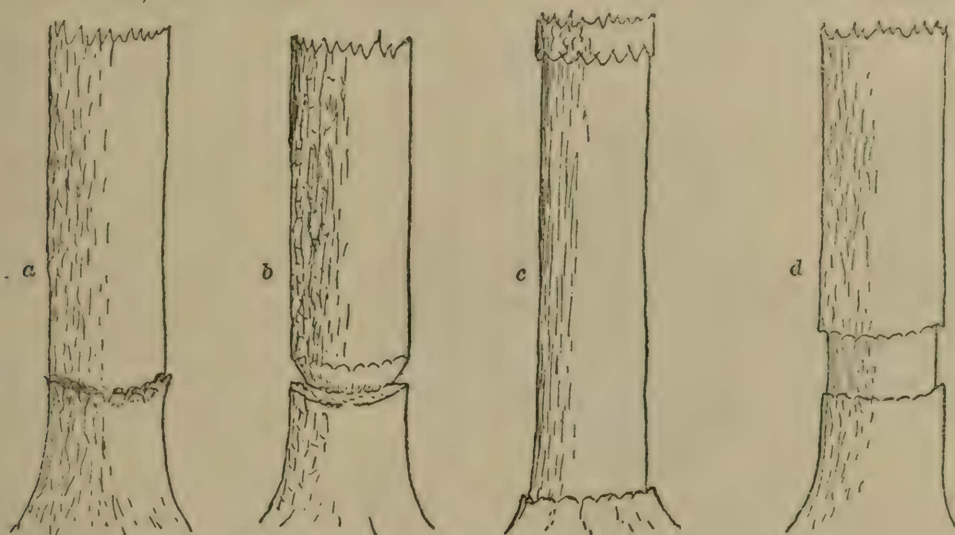


FIG. 25.—Different methods of girdling trees: *a*, hack girdled: *b*, girdled to heartwood; *c*, hack girdled and peeled; *d*, belt girdled. (From Bulletin No. 28, new series, Division of Entomology, U.S. Dept. Agr.)

in the life history of the insect, and in the discovery that if living spruce trees are hack-girdled (fig. 25) just before the pollen commences to fall from the Red Spruce and when it is falling from the birches, the conditions, as related both to the flight or swarming period of the beetles and to the physiological phenomena of the tree, will be most favorable for the attraction of the beetles to such trees; thus, the beetles may be made to concentrate their attack upon numerous girdled trap trees to be subsequently destroyed during the fall, winter, and early spring months, either by the ordinary lumbering operations, which insures the removal of the timber from the forests before the insects emerge, or by felling the trees and removing the bark from the lower two-thirds of the trunk, this method to be supplemented as far as possible by the felling and barking of such other trees as are found to be infested. By this means the number of the beetles may

be so reduced within large areas as to effectually protect the remaining living timber. It was also determined that the adoption of improved forestry methods, which require the intelligent harvesting of the matured crop of timber, is doubly beneficial to the forest. These methods involve the removal of the trees above 12 inches in diameter, which are the only ones attacked by the destructive beetle, and leave the younger growth, which is exempt from attack, to produce a future supply of timber.

THE DESTRUCTIVE PINE-BARK BEETLE.

(*Dendroctonus frontalis* Zimm.)

The devastation wrought by this beetle in the Virginias and adjoining States attracted general attention at the time, and was the subject of special investigation by the writer. This insect may be considered as one of the most destructive enemies of Southern pine forests. Published records of depredations by insects in the pine forests of the Southern States within the past century indicate that it has been the cause of repeated widespread damage, similar to that resulting from its work in the Virginias.

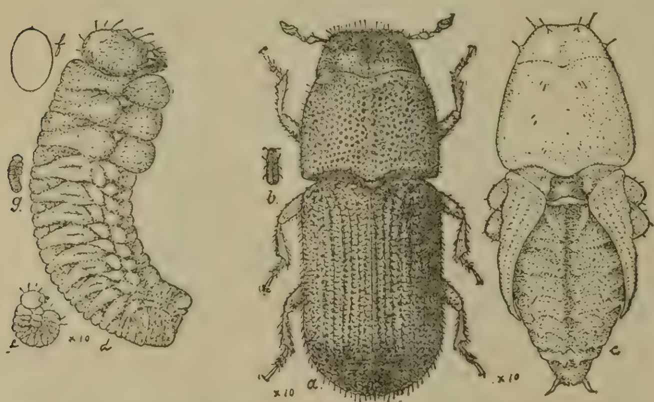


FIG. 26.—Destructive pine-bark beetle: *a*, adult beetle, enlarged; *b*, adult, natural size; *c*, pupa, enlarged; *d*, larva, enlarged; *e*, young larva, enlarged; *f*, egg, enlarged; *g*, larva, natural size. (After author, in Bulletin No. 56, West Virginia experiment station.)

DESCRIPTION OF THE VARIOUS STAGES OF THE BEETLE.

THE ADULT (fig. 26, *a*) is a small, rather slender, brownish to black beetle, varying in length from one-twelfth to one-sixth of an inch (2.2 to 4.2 mm.). It is distinguished mainly by the very broad head and nearly parallel sides of the prothorax.

THE PUPA (fig. 26, *c*) also differs in having a proportionately larger prothorax, with sides less constricted in front.

THE LARVA (fig. 26, *d*) is strikingly different from that of the spruce-destroying beetle in the globular form of the curled-up, freshly hatched individuals (fig. 26, *e*) and in the much enlarged prothoracic segments; also in the last abdominal segments being truncated and unarmed.

HABITS OF THE ADULT AND LARVA.

In this species the adults normally invade the bark of the middle trunk of medium to large pine and spruce trees and the middle to

FIG. 27.—Work of destructive pine-bark beetle: *a, a, a, a*, characteristic forms of primary galleries; *b*, normal forms of larval mines; *c*, abnormal forms of larval mines—all slightly reduced. (Original.)

lower portion of the smaller ones. The habit of attack and methods of excavating galleries is similar to that of the spruce beetle, but the

character of the primary gallery is strikingly different. Instead of extending nearly straight up and down the tree it extends from the entrance in a transverse and tortuous course through the inner bark (fig. 27). Those of different pairs of beetles frequently cross each other, so that the many primary galleries, independent of the larval mines, serve to completely girdle the tree and kill the bark, thus causing a much more rapid death of the bark and foliage than when the primary galleries, like those of the spruce beetle and the pine beetle of the Black Hills, extend parallel with the elongated sieve tissues and cells through which the life-supporting and wood-forming liquids pass. The larval burrows are also quite different, being normally very short and broad. The pupal cells are usually excavated in the outer dry bark, while those of the spruce beetle are normally in the outer portion of the inner bark.

The time required for the development of a brood varies greatly with the season, latitude, altitude, etc. In West Virginia, at a medium altitude of 1,000 feet above tide, there appear to be two broods, one emerging in August and the other in September.

The winter is passed in the adult stage and in all stages of the larva, with possibly a few eggs and pupæ.

How the trees are killed.—The trees are killed by the girdling effect of the primary galleries in the bark of the middle portion of the trunk—which, as has been demonstrated, is the most vital part, or at least has less power of resisting injuries than the lower portion and base. Instead of the leaves of infested trees remaining green until the next season, as is the case with trees infested by the spruce beetle and the pine beetle of the Black Hills, all except those attacked late in the season commence to fade in a few weeks after the attack; so that trees attacked about the middle of July will be entirely dead and the leaves brown by the first of November or earlier, when all of the broods of beetles will have emerged. The trees infested with broods at the beginning of winter may present in the foliage all stages of color, from yellowish to perfect green.

Kinds of trees attacked.—This beetle is known to attack the Shortleaved Yellow Pine, Pitch Pine, Scrub or Virginia Pine, Table Mountain Pine, and White Pine, and recent observation indicates that the Loblolly and Longleaf pines are also attacked and killed by it. It also attacks and kills the native Red Spruce and the introduced Norway Spruce.

Distribution and area of principal depredations.—This species with its work has been observed by the writer in West Virginia, Virginia, Maryland, North Carolina, South Carolina, Texas, and the District of Columbia, and has been recorded by other writers from Georgia to Lake Superior, Florida, Colorado, Arizona, and California. The Western forms heretofore associated with it have, however, been

recently found by the writer to represent several distinct species. The destructive invasion in 1890–1892, as determined by the writer, extended from the western border of West Virginia through Maryland, Virginia, and the District of Columbia, and northward into southern Pennsylvania and southward into western North Carolina, an area of over 75,000 square miles, in which a vast amount of pine and spruce was killed by it. In many places in West Virginia and Virginia nearly all of the pine of all sizes, from a few inches in diameter to the largest trees, was killed on hundreds and even thousands of acres, while shade and ornamental trees within the same area suffered the same as those in the forest. The total destruction of the pine and spruce of the entire area was threatened, but the severe freeze of December, 1892, and January, 1893, together with natural enemies, exterminated the pest or so reduced its numbers that no more timber died after the summer of 1893, since when to the date of the present writing not a living example of the beetles has been found north of North Carolina.

PROBABLE BEGINNING OF A NEW INVASION IN THE SOUTH.

Recent investigation in the Southern Appalachian region has demonstrated the fact that the insect is living there, and that scattering clumps of trees are being killed by it as they were in the early stages of the great invasion of 1890–1892.

EVIDENCE OF AN OLD INVASION IN TEXAS.

It has also been recently determined that a great amount of timber died in the Longleaf Pine region of eastern Texas between 1882 and 1885, which, as evidenced by the dead beetles found preserved in the pitch and the characteristic galleries in the bark from the old dead trees, was probably due to the presence of this insect in destructive numbers at that time.

Knowing what devastations were wrought by this beetle in the Virginias within two or three years and what it evidently did in Texas within about the same length of time, we conclude that during a series of years of especially favorable conditions it is capable of devastating the entire pine and spruce forests of the South. Therefore, it presents, in the writer's opinion, the most important forest insect problem in this country, and one which demands immediate action to prevent a possible widespread invasion, which would be a real calamity to the South.

METHODS OF PREVENTING DESTRUCTIVE INVASIONS.

From what has been learned of the habits of this insect, it is known that it passes the winter in different stages in the inner and outer bark of trees attacked by the adult beetle in September to November. The trees so infested may be detected by the faded and yellowish foliage

of the dying trees, or by the pitch tubes and borings in the loose outer bark and at the bases of such infested trees as show no change in the foliage from the normal green. The principal infestation is in the bark of the main trunk of medium to large trees, and among the lower branches to the bases of small trees and saplings.

In order to effectually destroy the insect it is only necessary to fell the larger trees, remove the bark from the trunks, and burn it. It is entirely unnecessary to burn or otherwise destroy any part of the wood, because the destructive beetle does not enter the wood and rarely breeds in the bark of the tops and branches, but with this particular species it is necessary to burn the bark removed in the winter, because the matured larvæ, pupæ, and adults pass the winter in the outer dry bark, where they would otherwise survive and emerge in the spring to attack other trees.

The infested small trees may be felled and barked or burned, or the bark removed from the infested parts by means of suitable barking tools, as is sometimes done in European forests.

The summer broods of the insect can also be destroyed by felling and barking recently infested trees.

As an example of what may be accomplished by the cutting and peeling process, Mr. G. H. Warner, in March, 1902, cut the infested trees in four different widely separated clumps of from 1 to 2 acres each in the forest of the William Gillette place, near Tryon, N. C., and removed the bark and burned it. Examination of this place by the writer in July, and of the vicinity in November, of the same year, indicated that a sufficient number of the beetles and their broods had been thus killed to protect a very large area from further attack. At least no recently attacked trees were observed on the place or in the immediate vicinity.

It is well known by people in the South that if a pine tree standing in the midst of a healthy forest is girdled, struck by lightning, felled by ax or storm, or otherwise seriously injured, during the middle of the summer, it will cause the death of the other pine trees immediately surrounding it, over areas varying from a few rods to several acres. This is due to the fact that the destructive beetle breeds in such trees, and emerges in sufficient numbers to attack and kill the living timber. Such trees should be felled and have the bark removed, whenever practicable, soon after the leaves begin to fade.

It must be remembered that the bark and wood of trees dying or dead from the work of the destructive beetle are always infested by many other kinds of bark-beetles and wood-boring beetles, as well as bark-grubs and wood-boring grubs, the latter known locally as "bore worms" or "sawyers." Therefore, these must not be confused with the real destroyer. The destructive beetle and its characteristic galleries in the bark can be easily distinguished from the secondary enemies by

comparing them with fig. 24, *d*, and descriptions. It is a common mistake by the unentomological observer to conclude that some of these secondary enemies, especially the sawyer, are to blame for the death of the trees.

TRAPPING THE BEETLE AND ITS BROODS.

Some facts in the habits of the beetle in the present infested region recently determined by the writer indicate clearly that it can be easily trapped during the summer and destroyed by means of the well-known method of girdled and felled trap trees. It was found that the adults are attracted to storm-felled and otherwise felled and injured trees, and that such trees, if neglected, form a nucleus for the rapid multiplication of the insect and its spread to healthy standing timber. Therefore, if felled and girdled trees are provided at the proper time, so that the beetles will be attracted to them at the period of their greatest flight, they will attack such trees in preference to the living uninjured ones. Then, after they have entered the inner bark and the broods are partially developed, that is, before they have entered the outer bark, it will only be necessary to remove the bark to effectually destroy them, and thus protect the healthy timber. If, however, the removal of the bark is neglected until the broods have entered the outer dry portion, it will be necessary to burn it as soon as it is removed.

THE PINE-DESTROYING BEETLE OF THE BLACK HILLS.

(*Dendroctonus ponderosæ* Hopk.)

This beetle is now causing widespread destruction to the Bull Pine in the Black Hills Forest Reserve and is the subject of detailed investigation by the Department. The fact that it may spread through the entire Rocky Mountain region and cause general destruction of the pine and spruce renders it an insect of special interest and importance.

DESCRIPTION OF THE BEETLE AND ITS WORK.

THE BEETLE (fig. 28).—The fully matured adult is a stout dark-brown or black beetle, individuals of which vary in length from about one-sixth to one-fourth of an inch (4 to 7 mm.). It differs from the spruce-destroying beetle, with which it agrees in size, mainly in the absence of long hairs on the prothorax and elytra; and from the destructive pine-bark beetle in its much larger size, also in other specific characters which would require a technical description.

THE EGG differs but slightly from that of the spruce beetle.

THE LARVA (fig. 29) resembles that of *D. frontalis*, but differs in being of much larger size and in having the prothoracic segments much less enlarged.

THE PUPA (fig. 30) is scarcely to be distinguished by the ordinary observer from that of the spruce beetle.

Characteristic features of the work of the beetle and larva.—The attack of this beetle on living trees and the general features of its operation beneath the bark and method of killing the trees is similar to that of the two preceding; but it differs in the time of flight, character of galleries (fig. 31), and other minor details. It commences to emerge and fly during the last half of July, and the adults, which subsequently develop from different stages of the hibernating broods, continue to emerge until in September. The main swarm, however, emerges during the last half of July and the first half of August and attack the living timber. They settle on widely separated clumps of trees, or invade the living timber adjoining that from which they emerged. The number of trees invaded in one locality varies from two or three to many hundreds, or even thousands. Each tree is attacked by a great number of pairs of beetles, which enter the bark from near the base up to about the middle of the trunk of medium-sized to large trees, and on the lower portion of the main stem of the smaller ones. They then begin to excavate the entrance burrows, which are usually in crevices hidden by the flakes of the dry bark. The reddish sawdust-like borings thus produced fall to the ground or lodge in the flaky bark or the outer part of the trunk. When the beetles enter the inner bark, or bast, the tree commences to exert its resistance to the enemy by throwing out pitch to fill and heal the fresh wounds in the living tissue (fig. 32). During the earlier attack the borings and pitch are pushed out by the beetles and formed into pitch tubes at the mouth of the entrance burrows; while later, in August, when the tree is apparently less able to exert resistance, pitch tubes are not necessarily formed, but the borings lodge in the loose bark and around the base of the tree.

Fig. 28.—The pine-destroying beetle of the Black Hills: *a*, adult beetle, enlarged; *b*, adult beetle, natural size. (Original.)

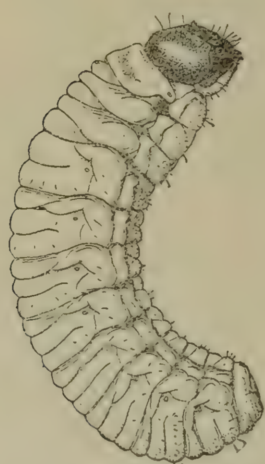


Fig. 29.—Larva of the pine-destroying beetle of the Black Hills.

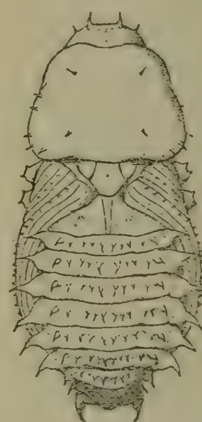


Fig. 30.—Pupa of the pine-destroying beetle of the Black Hills.

The inner bark is entered obliquely, or transversely to the cambium or outer portion of the wood, where a broadened cavity is excavated for the accommodation and temporary occupation of the parent beetle

until the principal flow of pitch is exhausted. The gallery is then extended transversely or subtransversely for a short distance, seldom more than an inch or two, and then longitudinally up or down the tree, varying in length from a few inches to over 2 feet (fig. 31). As soon as the gallery has been extended 1 or 2 inches from the entrance and basal cavity, small notches are excavated in the sides of the gallery, in each of which an egg is deposited, and so on until the gallery is completed. As the eggs are deposited, the borings, instead of being thrown out at the entrance, are closely packed in the entrance burrow, basal cavity, and gallery, except near the farther end, which is kept open and enlarged or extended to one side or the other, as it is occupied by the parent beetles, after the work of constructing the egg galleries is completed, until they die.

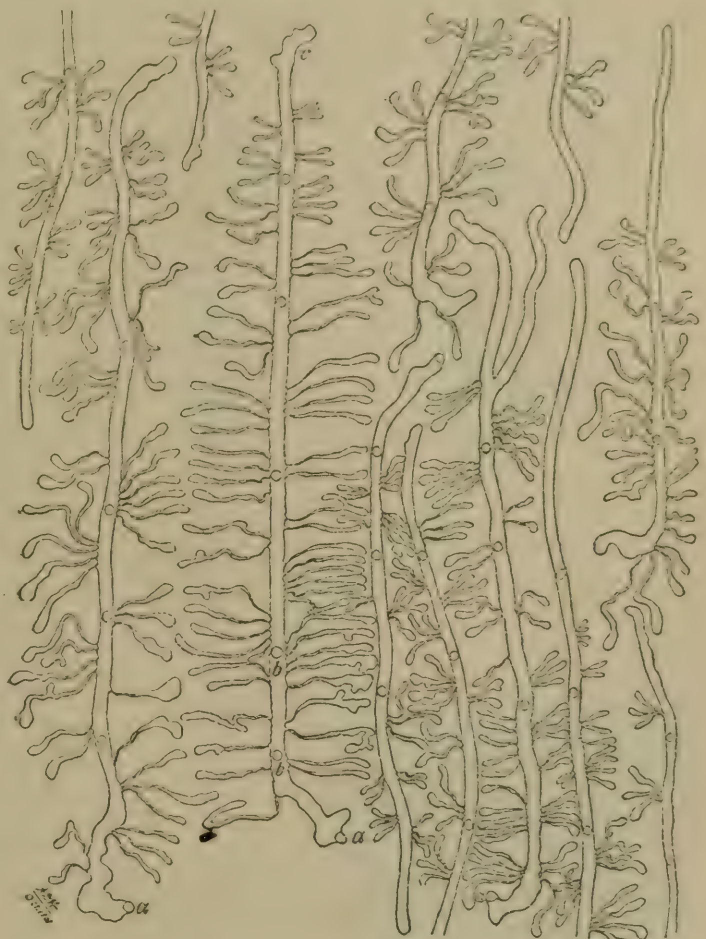


FIG. 31.—Work of the pine-destroying beetle of the Black Hills: *a*, *a*, *a*, entrance and basal chamber; *b*, ventilating holes in roof of gallery; *c*, termination of gallery (larval mines extending from each side of primary galleries)—all much reduced. (After author, in Bulletin No. 32, new series, Division of Entomology.)

The bark of an infested tree is usually occupied by one of these primary galleries every 1 to 6 inches of the circumference, from near the base to near the middle of the trunk; therefore they effectually check the normal movement of the sap, and the larval mines, which radiate from the primary gallery, destroy the intervening bark, and complete the girdling process. The larval mines are similar in character to those of *D. frontalis*, and quite different from those of *D. piceaperda*, as will be noted by comparing figs. 24 and 31. The larvæ undergo their transformation to the pupa in cells excavated in the inner bark at the end of the larval gallery.

KINDS OF TREES ATTACKED.—So far as has been observed, this beetle attacks and kills the Ball Pine (*Pinus ponderosa*) and the White Spruce (*Picea canadensis*), but shows a decided preference for the pine.

DISTRIBUTION OF THE SPECIES AND EXTENT OF ITS DEPREDATIONS.—The beetle has been reported by Professor Gillette from central Colorado, which indicates that it may be found throughout the central Rocky Mountain region; but, so far as determined, it has not proved so destructive anywhere else as in the Black Hills Reserve, where in the past six years from 400 to 600 million feet of timber, according to various estimates, have been killed by it.

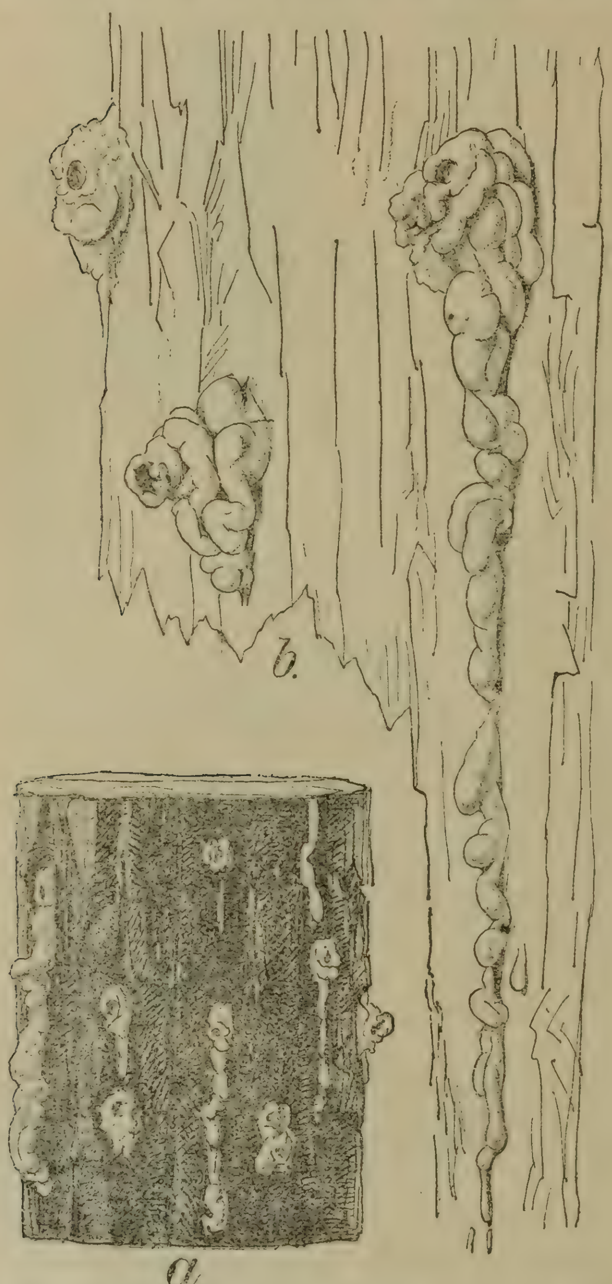


FIG. 32.—Work of the pine-destroying beetle of the Black Hills: *a*, pitch tubes on surface of bark, much reduced; *b*, same, two-thirds natural size. (Original.)

Recent investigations indicate that at least 80 per cent of the merchantable timber west of Spearfish Creek to the Wyoming line has been killed. There is a decided increase in the spread of the depredations by the beetle eastward and southward. It is threatening the large areas of healthy timber in the southern hills, and unless checked it will doubtless extend its destructive work in that direction, as it has northwestward.

The Black Hills Forest Reserve is recognized as one of the most important in the country, especially in its immediate relations to the support of great mining industries. The annual product of gold mined in the Black Hills amounts to about $10,000,000. The methods of mining require the use of some 20 million feet of mine timbers each year. The process of extracting the gold from the ore requires thousands of cords of wood for fuel. The average low grade of the ore and the expensive processes of mining and reduction require that the supply of such timber be readily accessible and procurable at a low price. The cost of transportation of timber from other reserves or other Western forests would prohibit its use. Therefore, as stated by the superintendent of one of the principal mines, "the mining interests

of South Dakota are dependent upon the limited timber resources of the Black Hills." The dying of the timber is threatening the life of the mining industry and of all the many other interests which depend upon it.

CHARACTERISTIC FEATURES OF THE INFESTED AND DEAD TIMBER.

The characteristic features which are of importance to the reserve officials, lumbermen, and residents in recognizing the presence and work of the pine-destroying beetle are as follows:

Borings and pitch tubes.—The first indication of attack is the red dust or borings lodged in the loose outer bark or scattered upon the ground about the base of the tree. The next and a more conspicuous evidence is the presence of numerous small masses of pitch, or so-called pitch tubes, on the outer bark at the mouth of the entrance burrows (fig. 32).

Appearance of the leaves.—The leaves of the trees attacked by the beetle in July to September in any year, for example, in 1899, retain their normal green until May of the next year, that is, till 1900. Then the leaves of the lower branches begin to fade and gradually change to yellowish. This condition rapidly spreads toward the top, until all are dead by the first or middle of August. The trees in this stage are designated by lumbermen as "sorrel tops." By the time, and often before, all the leaves are dead the broods of beetles have emerged and entered the living timber. After this the recently dead and vacated trees are of no further importance as sources of danger as breeding places for the pine-destroying beetle.

By the summer of the next year (1901) the leaves change to a reddish brown and commence to fall. The trees in this stage are referred to as "red tops."

By the summer of the year after that (1902) all of the leaves have fallen, and in this stage the trees are referred to as "black tops." Still later (1903–1904) most of the tops will break off. They are then called "broken tops."

The bark of the lower half or two-thirds of the newly infested trees usually dies within a few weeks after the primary galleries are completed, or by the middle to the last of September of the year in which the attack is made; and when thoroughly infested the bark may then be readily separated from the wood. The sapwood will then be found changed from the natural color to a bluish hue.[a]

[a] Bluing of the wood.—According to information from Dr. Von Schrenk (who has made detailed investigations of the deterioration and decay of the wood of the beetle-killed trees), the bluing of the sapwood of the infested trees is due to a fungus which enters the burrows in the bark made by bark beetles and those in the wood made by timber beetles. The writer has determined that this blue wood trouble is not only associated with the recently excavated galleries of the destructive beetle, but also with those of the numerous other bark-boring and wood-boring beetles, which follow the attack of the former and excavate their primary galleries in the living bark and sapwood.

Evidence of the work of the beetle on the surface of the wood.—The peculiar grooves and marks in the surface of the wood made by the pine-destroying beetle during the process of excavating the primary or egg galleries, as seen on the barked surface of dead trees, sawlogs, railroad ties, mine timbers, etc., are always unmistakable evidence of its work (Pl. XXIX). While there are many other kinds of bark beetles and bark-boring grubs which follow the attack of the destructive beetle, and excavate each its peculiar kind of gallery or groove on the wood, none of these marks can be mistaken for the peculiar longitudinal grooves made by the destructive species.[a]

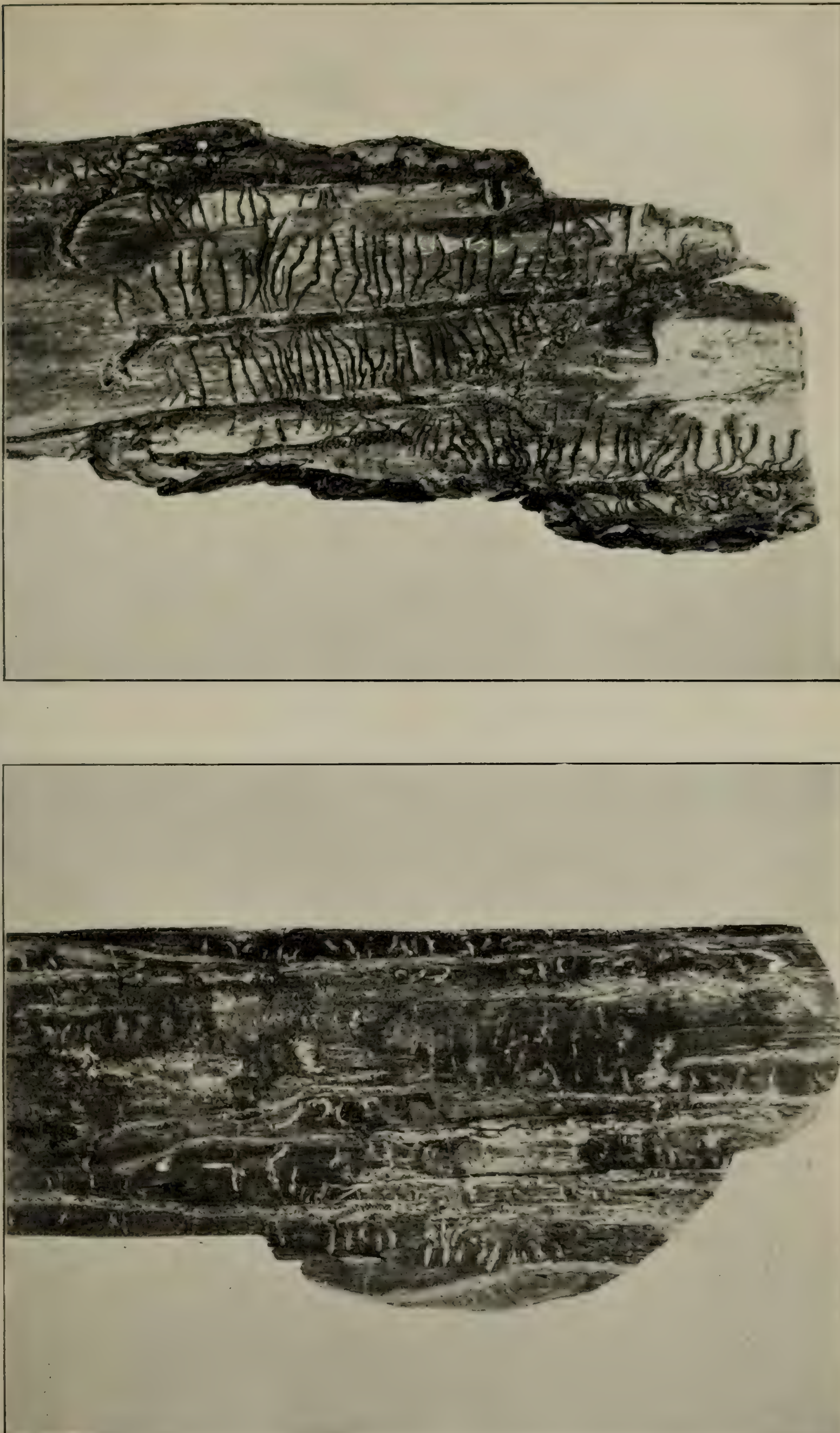
METHODS OF COMBATING THE PEST.

Experiments with girdled trees.—Experiments with girdled and felled trees, to determine whether or not the trap-tree method would be practicable in dealing with the pine-destroying beetle in the Black Hills Reserve, seem to demonstrate, among many other important facts in the life history and habits of the beetle, that while some of the girdled as well as felled trees were infested, the near-by living and uninjured trees were equally attacked. Therefore, it would seem from the results of this season's work that the trap-tree method, which is so admirably adapted for the control of similar troubles by other kinds of bark beetles in this country and Europe, is not adapted to the conditions attending the Black Hills trouble. This is probably due to some peculiar characteristic of the species or variety of pine involved.

Further experiments, however, may show that while none of the several methods and dates of girdling and felling the trees are available in checking or controlling the insect in its present magnitude, some one or more of them may prove to be adapted to the prevention of its recurrence after it has once been brought under control by other methods.

Cutting and barking the infested trees to destroy the young broods.—After a thorough study of the prevailing conditions in the Black Hills Reserve, both as regards the extent of the present depredations, the peculiar habit of the depredator, and the relative abundance of the several kinds of natural enemies which prey upon the parent beetles and different stages of its broods, the writer is convinced, as stated in his recommendations, that in order to destroy a sufficient number of the young stages of the beetles to render any special service toward checking or ending the depredations, it is necessary that the beetle-infested trees in all of the principal areas of new infestation throughout the reserve be cut and the bark removed from

[a] For illustrated forms of galleries made by secondary enemies of the trees, see "Insect enemies of the pine in the Black Hills Forest Reserve," Bulletin No. 32, new series, Division of Entomology, U. S. Dept. Agr.



WORK OF THE PINE-DESTROYING BEETLE OF THE BLACK HILLS.

[On left, primary galleries and larval mines in inner bark, from dying tree; on right, gallery grooves and marks on barked surface of chip from beetle-killed tree. From photograph.]

the infested parts of the trunks between the 1st of September (1902) and the 1st of May (1903).

It is also evident that if these principal areas of newly infested timber in the western and southern hills are cut over, the natural enemies, including insects and birds, will be able to so reduce the numbers of the beetles left in the scattering uncut infested trees as to prevent the continuation of their destructive ravages, and that the pest will thus be kept under complete control, especially if the future management of the reserve shall provide for the cutting of such newly infested clumps of trees as from time to time may be found. Recommendations to this effect have been submitted by the writer to the Bureau of Forestry and to the General Land Office for consideration in their future management of the forest and administration of the reserve.

OTHER DESTRUCTIVE SPECIES OF DENDROCTONUS.

The other species of the genus Dendroctonus which have been found by the writer to be specially destructive, but which for lack of space can not be described in this article, are four undescribed and two described species. One is destructive to the Silver or Mountain White Pine, in Montana and Idaho. Another destroys the Red Fir from Idaho to western Washington and Oregon. One of the described species (*Dendroctonus brevicomis* Lec.) kills the Western Yellow Pine in California and Oregon to western Idaho. The other described species (*D. approximatus* Dietz), together with two undescribed species, attacks and kills the Bull Pine in northern Arizona.

With a few modifications to suit local conditions and varying features in the habits of these species, the same recommendations for dealing with troubles caused by *D. piceaperda*, *D. frontalis*, and *D. ponderosæ* may be adopted.

SUMMARY.

The principal destructive enemies of coniferous forests in this country belong to the Dendroctonus genus of bark beetles.

THE SPRUCE-DESTROYING BEETLE has killed billions of feet of spruce timber in the Northern spruce forests in the past seventy-five or eighty years. It can be controlled by cutting the infested trees during the fall, winter, or early spring months, and removing the bark from the infested parts of the main trunks. It can also be attracted to trap trees hack girdled during the last week in May or first week in June, and subsequently destroyed by felling them and removing the bark in the summer after the broods are partially developed, or during the following winter.

THE DESTRUCTIVE PINE BARK-BEETLE destroyed millions of dollars worth of pine and spruce forest and shade trees in an area including

West Virginia, Virginia, Maryland, and the District of Columbia between 1890 and 1892.

The natural home of the species is evidently in the Southern Appalachian region, where it is now at work, and is a menace, not only to the pine and spruce of that region, but to the coniferous forests of the entire Southern and Eastern United States.

If taken in time, this pest can be controlled by felling the infested trees and removing the bark from the infested parts of the trunks and burning it; also by means of trap trees.

THE PINE-DESTROYING BEETLE OF THE BLACK HILLS has killed many hundreds of millions of feet of pine timber in the Black Hills Forest Reserve within the past six or seven years, and is at the present time threatening the destruction of the remaining timber of the reserve, together with the great mining and other industries which depend upon the forest resources.

In order to check the ravages of this beetle and protect the remaining living timber, it is necessary to cut and bark all of the principal clumps and bodies, or an aggregate of at least 50 per cent of trees which were attacked by the beetle during the summer of 1902—a remedy which has been recommended by the writer and has been adopted by the General Land Office to be applied so far as it is possible and practicable to do so.

GENERAL RECOMMENDATIONS.

It is of the greatest importance that the commencement of depredations similar to those described in this article, as indicated by isolated clumps of dying trees in the pine or spruce forests of any section of the country, should be reported to the Department of Agriculture as soon as discovered, in order that the matter may be investigated and prompt information given on the proper course to pursue in each particular case to prevent the widespread depredations which may follow neglect.

ANALYSIS OF WATERS AND INTERPRETATION OF THE RESULTS.

By J. K. Haywood,

Chief of Insecticide and Agricultural Water Laboratory, Bureau of Chemistry.

PURPOSES OF THE ANALYSIS OF WATERS.

There are several kinds of analyses that may be made of samples of water, all very different in their scope and purpose. A sanitary analysis may be desired to determine the adaptability of water for drinking purposes. An analysis of water for irrigation may be desired, which would include the determination of various salts, harmful, helpful, or practically neutral in their effect on vegetation. A mineral analysis of water may be required to determine whether it contains compounds with marked medicinal qualities, or an analysis of water for boiler purposes may be desired that would include the determination of the substances in solution which would either form scales or injure the boiler by directly attacking the iron plates. There are other purposes for which water may be used and for which special determinations are often made, as, for example, in different manufacturing enterprises; but these are so varied and of so little interest to the general public that they will not be considered in this paper.

SANITARY WATER ANALYSIS.

In examining a water for sanitary purposes those constituents are quantitatively determined which show whether it has been contaminated with foreign matter, such as general sewage, human and animal excrement, etc. The determinations usually made are chlorin, free and albuminoid ammonia, nitrites, nitrates, oxygen-consuming capacity, and total solids.

CHLORIN.

Chlorin is present to some extent in nearly all waters, because it is dissolved from both the soil and air, usually as sodium chlorid. There is another source from which sodium chlorid (common salt) may be derived, that is, from sewage, and especially from the urine of human beings. This is, therefore, one of the most important constituents to be determined in a water analysis of this character. If the amount of chlorin is high, it is a general indication of contamination from human urine, but this is not always the case. In certain districts the

sodium chlorid in all waters is high, because the soil is rich in this constituent, or because a body of salt water is near by. The only way we can judge, therefore, whether this salt is naturally present or is introduced by sewage is to know the amount of sodium chlorid in waters of the same district which are of undoubted purity. If the amount of chlorin in the water under examination is markedly higher than this so-called "local normal," human contamination is strongly to be suspected.

FREE AND ALBUMINOID AMMONIA.

Free and albuminoid ammonia are present in small amounts in practically all waters, but when present in large amounts they usually indicate organic contamination, especially of animal origin, since organic matter from animal sources contains much more nitrogen than does vegetable organic matter. Free ammonia is not in itself injurious, but indicates that nitrogenous organic matter has been present, which, through the agency of oxygen, bacteria, etc., has been transformed into harmless ammonia. Of course, if organic matter has been present, the water may still contain chemical bodies, or bacteria which would have a very injurious effect upon the system. Albuminoid ammonia is not present already formed in the water, but is formed from nitrogenous organic bodies by treating them with an alkaline solution of potassium permanganate. A large amount of this substance usually indicates that organic matter, in a fresh or semiputrid condition, is present. Just as there are exceptions to most rules there are exceptions to the general rule that high figures for free and albuminoid ammonia indicate harmful organic contamination. For example, in many deep wells that are known to be pure, the free ammonia often runs as high as 0.70 to 0.80 part per million, while the amount that is ordinarily present in pure water is seldom above 0.05 to 0.10 part per million. This is doubtless due to the reduction of nitrates that have been formed in the soil in times past by sulphid of iron or some other harmless agent at the bottom of the well. Rain water, also, especially when gathered near large cities, contains quite a large amount of free ammonia that has been washed from the air. Again, albuminoid ammonia often runs rather high, say 0.20 to 0.40 part per million in streams which contain much living plant life, the water from which is not on that account objectionable.

NITRITES.

Nitrites in water are usually formed from ammonia by the action of nitrifying organisms upon this compound, and are the connecting link between ammonia on the one hand and the fully oxidized nitrates on the other. They may also be formed by the reducing action of a large amount of organic matter upon nitrates. Since nitrites are not

permanent and are only transition products, their presence, even in small amounts, usually indicates that active fermentation is going on and that the water is not able to fully oxidize the harmful organic matter into harmless nitrates. Whenever they occur in surface waters organic contamination is to be strongly suspected. In some cases nitrites may occur in waters without indicating contamination. Many springs and deep wells, for example, which can not in any way be contaminated, contain nitrites which are not present as a transition step in the oxidation of organic matter, but are formed from nitrates in the soil by the reduction of these bodies by ferrous iron and other reducing substances. The accepted standard for American rivers, as proposed by the late Professor Leeds, is 0.003 part of nitrogen as nitrite per million.

NITRATES.

Nitrates in water are the final oxidation product of the nitrogen of organic matter, and when present in at all large quantities indicate that nitrogenous organic matter (especially animal matter) has been present in the water and has been oxidized. Because a large amount of the nitrogen of organic matter has been converted by oxidation into harmless nitrates it does not necessarily follow that the water is fit for use, since bacteria may remain which would give rise to disease. Nitrates are present in nearly all waters in small amounts, and the amount naturally present is much higher in some localities than in others. A "local normal," therefore, is of great aid in judging of the purity or nonpurity of any particular sample in so far as nitrates are concerned.

OXYGEN-CONSUMING CAPACITY.

The oxygen-consuming capacity figure in water analysis gives some idea of the amount of organic matter present, especially that of vegetable origin, since it is a rough measure of the amount of organic carbon contained in the water. A large figure does not necessarily indicate that the water is unfit for drinking purposes, as in many peaty streams the organic matter of vegetable origin may be very high and yet the water be unobjectionable. It is only when the oxygen-consuming capacity is judged, in conjunction with the other figures obtained, that any conclusion of a positive nature in regard to potability can be drawn. For example, if the albuminoid ammonia is high and the oxygen-consuming capacity also, the presence of organic matter of vegetable origin is indicated. If the albuminoid ammonia is high and the oxygen-consuming capacity is low, the presence of organic matter of animal origin is indicated. In the latter case, if the figure for chlorin is markedly above the "local normal," contamination from a privy is to be strongly suspected.

TOTAL SOLIDS.

While the determination of total solids in water is nearly always made, there is no figure in water analysis which shows so little its adaptability for drinking purposes as this one. If the figure is extremely high, salts which have a marked physiological action may be suspected, but they are not necessarily present. Some water analysts would cast aside all doubt as to the utility of this figure by declaring that waters containing above 686 parts per million are to be condemned, but such is not the case, as there are many instances, especially in the West, of water containing 1,200 parts per million and over being used without apparent evil results. It is, of course, self-evident that when the salts are high it depends more on what salts are present than on the amount of them whether or not the water is fit for drinking purposes.

In some cases other constituents of water are determined in a sanitary analysis, as the phosphates, which indicate whether urine has contaminated the water; determinations are also made of its odor, color, or taste, all of which information is sometimes useful, but seldom leads to definite conclusions.

CONCLUSIONS REGARDING ANALYSIS OF WATERS FOR SANITARY PURPOSES.

From what has been said above, concerning the various determinations to be made in a drinking water, it will be seen how misleading is the judgment of a sample of water from any one figure. All of the constituents and their amount must be taken into consideration when passing upon any particular sample. Since there are also exceptions to the general rules laid down above, a complete history of each sample of water is necessary to enable the analyst to judge whether certain of the figures are high, because of contamination, or by reason of some totally unobjectionable cause.

There are certain points that should be borne in mind when considering a sanitary analysis of water, viz, when all the figures are high or certain ones are extremely high, the chemist can usually say with a reasonable degree of certainty that the water is contaminated; but in some cases all of the figures may be low, thus indicating to the chemist that the water is perfectly healthful and yet bacteria may be present which would have a very injurious effect upon the health of the consumer. In such cases as the latter, a sanitary analysis serves only as an indication, and not as a proof, and should be accompanied by a bacteriological examination to give results of a positive nature.

ANALYSIS OF WATERS FOR IRRIGATION PURPOSES.

In making an analysis of a water for irrigation purposes the following determinations are usually made: Silica, carbonic acid, bicarbonic acid, sulphuric acid, chlorin, calcium, magnesium, sodium, potassium,

phosphoric acid, and nitric acid. The first eight constituents give some idea as to whether the water will or will not be harmful to vegetation. The last three represent the most important plant foods, and thus give an idea of the beneficial effects that may be expected from the use of water containing them. Suspended matter is also determined for reasons that will appear later.

The constituents, excluding silica, do not usually occur as the free acids or bases, but are combined to form salts. A number of the following are present, in larger or smaller quantities, in irrigation waters: Calcium carbonate or bicarbonate, magnesium carbonate or bicarbonate, potassium carbonate or bicarbonate, sodium carbonate or bicarbonate, calcium sulphate, magnesium sulphate, potassium sulphate, sodium sulphate, calcium chlorid, magnesium chlorid, potassium chlorid, sodium chlorid, sodium nitrate, and sodium phosphate.

CARBONATES.

Calcium carbonate or bicarbonate is present in practically all irrigation waters, to a greater or less extent, usually in the latter form, since calcium carbonate is quite insoluble. Neither one of these salts is considered as being especially significant in an irrigation water, since they are not injurious to vegetation. Calcium carbonate may be helpful both in modifying the physical state of a soil and in favoring nitrification. There seems to be only one case in which a large excess of calcium carbonate in water might be injurious, and that is when such a water is applied year after year to a land containing sodium sulphate. If such land is not well drained the calcium carbonate and sodium sulphate are apt to gather in the standing water and react upon one another, thus forming the highly injurious salt, sodium carbonate.

Magnesium carbonate or bicarbonate is also nearly always present in irrigation water, but neither is considered of especial importance, since neither is of itself markedly injurious nor markedly beneficial to vegetation.

Potassium carbonate or bicarbonate does not occur in extremely large quantities in irrigation waters; and in so far as these do occur they are beneficial, since they furnish one of the necessary plant foods which is often deficient.

Sodium carbonate is that constituent of an irrigation water which when present in the land gives rise to "black alkali," so called because of the black spots that are formed by the action of this salt upon the humus of the soil. Sodium carbonate is one of the worst salts that can occur in an irrigation water, since it exerts a corrosive action upon the roots of plants, especially the young and tender roots.

Sodium bicarbonate has recently been shown to be less injurious to

plant life than sodium carbonate,[a] but waters containing a large amount of it should not be used, as such waters when evaporated from the land would probably leave behind most of the sodium bicarbonate, not as such, but as sodium carbonate, which would then form "black alkali" and corrode the roots of plants in the usual way.

SULPHATES.

Calcium sulphate is one of those salts which acts as an indirect plant food, and is often very beneficial when applied to the land in alkali regions, since it reacts with the harmful salt, sodium carbonate, to form the less harmful salt, sodium sulphate. That this may not appear to be antagonistic to the statement made above, that "calcium carbonate and sodium sulphate are apt to gather in the standing water and react upon one another, thus forming the highly injurious salt, sodium carbonate," it should be mentioned that this reaction is very likely a reversible one. If such is the case, calcium sulphate and sodium carbonate would under certain conditions react to form calcium carbonate and sodium sulphate, while under other conditions the action would be reversed, resulting in the formation of calcium sulphate and sodium carbonate from calcium carbonate and sodium sulphate.

Magnesium sulphate, which, with sodium sulphate and sodium chlorid, forms white alkali, is much milder in its action upon plants than sodium carbonate, yet, when present in large amounts, it also is injurious to growth, if not prohibitive. Irrigation waters should not be applied which contain an excessive amount of this compound, since it would collect from year to year and cause serious damage.

Potassium sulphate practically never occurs in very large quantities in irrigation waters, but, in so far as it does, is of benefit, since it furnishes one of the essential plant foods.

Sodium sulphate is the predominating constituent of white alkali. This salt is generally considered to be more injurious than magnesium sulphate, but less injurious than sodium carbonate, and waters containing a moderate amount of this salt may be used indefinitely. Irrigation waters containing large amounts of salts are apt to cause a rise or accumulation of white alkali in a short time.

CHLORIDS.

Calcium and magnesium chlorids do not occur in the usual irrigation waters in large quantities, and therefore their effect upon vegetation has not been as thoroughly worked out as that of the salts previously mentioned. Generally speaking, however, these two salts are supposed to be less injurious than sodium carbonate and more injurious than magnesium and sodium sulphates.

[a] Report No. 71, Division of Soils, U. S. Dept. Agr., "Some mutual relations between alkali soils and vegetation."

POTASSIUM CHLORID is not present in irrigation waters in large quantities, but, in so far as it is present, is of benefit as a plant food.

SODIUM CHLORID, in considerable amounts, is almost as much to be feared in an irrigation water as is sodium carbonate. While it is not as corrosive as the latter compound it is harder to get rid of, since it can not be neutralized in the soil in any way, but must be removed by drainage. The more corrosive sodium carbonate may be neutralized to a great extent by treating the land with gypsum.

SODIUM NITRATE AND PHOSPHATE AND SUSPENDED MATTER.

SODIUM NITRATE AND PHOSPHATE are present to a greater or less extent in most waters and are beneficial, since they supply those two essential plant foods, nitrogen and phosphoric acid.

SUSPENDED MATTER.—A determination of the suspended matter in irrigation water is of value for two reasons. First, the suspended matter contains very appreciable amounts of the three principal plant foods—potash, phosphoric acid, and nitrogen. In the second place, the suspended matter or silt is a very important consideration in many rivers where the reservoirs and canals that hold the water soon fill up on account of the suspended matter settling out. Thus, we see that, while the suspended matter in irrigation waters is of value for one purpose, its presence in large amounts is much to be deplored from an economic standpoint.

ORDER IN WHICH INJURIOUS SALTS AFFECT VEGETATION.

All that has been said above concerning the various salts and their action upon plants refers to them as they usually occur in alkali regions, mixed with one another, and not to the action of the pure salts. The order, therefore, in which the various injurious salts affect vegetation, as determined by practical experience in alkali regions, and beginning with the most injurious, is approximately as follows: (1) Sodium carbonate; (2) sodium chlorid; (3) magnesium and calcium chlorid; (4) sodium sulphate; (5) magnesium sulphate.

Sodium bicarbonate is not entered in the above list, since, as far as the writer can discover, its action has not been noted in practical experiments.

Very recently Kearney and Cameron[a] made a study of the effect of solutions of the pure salts found in irrigation waters and also of mixtures of these salts upon the roots of the white lupine and alfalfa. In pure solutions a determination was first made of the maximum concentration of salt that permitted a survival of the roots, and it was found that the salts acted in the following order, beginning with the most toxic: (1) Magnesium sulphate; (2) magnesium chlorid; (3) sodium

[a] Report No. 71, Division of Soils, U. S. Dept. Agr., "Some mutual relations between alkali soils and vegetation."

carbonate; (4) sodium sulphate; (5) sodium chlorid; (6) sodium bicarbonate; (7) calcium chlorid.

Further investigation showed that when each of these salts was mixed with any other of the salts the limit of endurance was nearly always changed to a marked extent. This was especially true when various salts were mixed with the nontoxic salts, calcium carbonate and calcium sulphate, in which case the limit of endurance was always raised very markedly. To a less extent this was also true for magnesium carbonate.

Each of the toxic salts was mixed with an excess of both calcium sulphate and calcium carbonate, and it was found that the limit of endurance of the roots was greatly increased, the order of toxicity being as follows, beginning with the most toxic: (1) Sodium carbonate; (2) sodium bicarbonate; (3) magnesium chlorid; (4) sodium chlorid; (5) calcium chlorid; (6) sodium sulphate; (7) magnesium sulphate.

Thus we see that when the various injurious salts are mixed with an excess of calcium sulphate and calcium carbonate, sodium carbonate is the most toxic and magnesium sulphate the least so. This order corresponds very closely to the order as given above, which has been found to be approximately correct in practical field experiments. This is what might be expected, since many of the alkali regions contain either calcium sulphate, calcium carbonate, or both, as well as the injurious salts.

It appears, therefore, that calcium carbonate and calcium sulphate especially, and magnesium carbonate to a less degree, when present in irrigation waters, must be regarded as extremely significant, since they have a marked mitigating effect on the toxic salts present in the soil. This has previously been recognized in the case of calcium sulphate when applied to lands containing sodium carbonate, but has not been generally recognized in the other instances.

AMOUNT OF SALTS ALLOWABLE IN IRRIGATION WATER.

The total quantity of salts allowable in an irrigation water and the quantity of each salt allowable, are hard problems to solve, since the answer depends upon so many conditions. One will at once note that since the various salts have a mitigating or nonmitigating effect upon one another, this must be taken into consideration in judging of water for irrigation purposes. For example, the same piece of land could stand much more of a water containing large amounts of both sodium sulphate and calcium sulphate in solution than it could stand of a water containing the same amount of sodium sulphate and but little calcium sulphate. Again, this would be true in the case of waters containing sodium chlorid and calcium sulphate, etc.

Further than this, the character of the land to be irrigated is perhaps the most important factor in judging of the irrigation water to be applied. On a heavy clay land, for example, which allows the

water to percolate through very slowly, a water very free from toxic salts must be used, since not only would all the salts present in the water be retained in the soil, but the salts already present could not be washed out, even by heavy irrigation and drainage. Furthermore, if the water stands upon the land too long it is apt to cause swamping and so injure the physical condition of the soil. On the other hand, if water containing a large amount of injurious salts was applied to a very light sandy soil, a large quantity of the salts in the upper 4 or 5 feet could be washed down and drained off, and the salts that were contained in the water alone would not be enough to injure crops.

In regard to this question of the total amount of salts allowable in an irrigation water, Hilgard[a] says:

Broadly speaking, the extreme limit of mineral content usually assigned for potable waters, viz, 40 grains per gallon (686 parts per million), also applies to irrigation waters; yet it sometimes happens that all or most of the solid contents is gypsum and epsom salt, when only a large excess of the latter would constitute a bar to irrigation use. When, on the contrary, a large portion of the solids consists of carbonate of soda or common salt, even a smaller portion of salts than 40 grains per gallon might preclude its regular use, depending on the nature of the soil to be irrigated.

In certain portions of the country water containing much more than 40 grains per gallon of total solids can be applied with impunity. For example, in New Mexico,[b] where sodium carbonate is seldom present and the soluble salts consist principally of sodium, magnesium, and calcium sulphates, water containing 1,000 parts per million total solids has been used upon trees for from eight to ten years without injury thereto. In the same Territory water containing 3,000 parts per million of total solids is used, but farmers are having trouble with alkali.

ANALYSIS OF MINERAL WATERS.

In making an analysis of mineral waters, all of the metal and acids held in solution should be determined, even though some are present in very small quantities, since it is upon very small amounts of certain substances that the distinctive character and physiological action of so many waters depend. The following substances are present in practically all waters, and are apt to be found in mineral waters in large quantities: Sodium, potassium, magnesium, calcium, iron, aluminum, chlorin, nitric acid, sulphuric acid, silica, carbonic acid, and bicarbonic acid.

The following constituents often appear in mineral waters, but usually in small quantities: Ammonia, lithium, manganese, barium, strontium, arsenic, iodin, bromin, fluorin, boric acid, phosphoric acid, nitrous acid, hydrogen sulphid, and a few other very rare elements.

In reporting these acids and bases they are joined to each other as salts, that is, to form chlorids, sulphates, carbonates, etc., of the various metals.

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[a] Bulletin No. 140 of the California Agricultural Experiment Station.

[b] Bulletin No. 34 of the New Mexico Agricultural Experiment Station.

CLASSIFICATION OF MINERAL WATERS.

The most scientific classification of mineral waters is that proposed by Dr. Albert C. Peale,[a] and modified by Dr. J. K. Crook, as follows:

Scheme of classification of mineral waters.

GROUP A: Nonthermal.
GROUP B: Thermal.

Class I:	Alkaline	Sulphated.
		Muriated.
Class II:	Alkaline Saline	Sulphated.
		Muriated.
Class III:	Saline	Sulphated.
		Muriated.
Class IV:	Chalybeate	Alkaline.
		Sulphated.
		Muriated.
Class V:	Neutral.	

DISCUSSION OF THE CLASSES OF MINERAL WATERS.

The presence or absence of gas is expressed by the following terms: (1) Nongaseous; (2) carbonated, if carbon dioxid is present; (3) sulphuretted, if hydrogen sulphid is present, etc.

Class I includes those waters which contain the carbonates or bicarbonates of the alkali metals or the alkaline earths, as a predominating constituent. Such waters are used in the treatment of dyspepsia, especially acid dyspepsia. They act as a diuretic, correct acidity of the urine, etc.

Class II includes those waters which contain the carbonates and bicarbonates and sulphates or chlorids of the alkali or alkaline earth metals on approximately equal terms. Waters of this class have somewhat the same medicinal qualities as those of Class I and Class III.

Class III is made up of waters containing sulphates and chlorids in largely predominating amounts. The sulphated salines usually act as purgatives or laxatives, according to the amount used. They increase the activity of the liver, regulate the bowels, increase the flow of urine, etc.

The muriated salines generally contain sodium chlorid in large amounts. Waters containing common salt promote the flow of urine. They are of value in cases of indigestion, since they increase the flow of digestive fluids and prevent putrefactive changes in the intestines. The waters containing chlorids of calcium and magnesium are used principally as tonics.

Class IV includes those waters which contain iron as one of the principal and most active constituents. Such waters act directly as tonics, and are principally used in cases of anæmia and general debility.

[a] "Mineral waters of the United States and their therapeutic uses."

Class V is composed of waters which contain only a small amount of mineral matter in solution. Although such waters do not contain enough of any particular salt to allow them to be classified under the four heads mentioned above, they may contain salts which have a very marked physiological action.

If waters were only classified as above, oftentimes very important constituents that are present in small amounts, but which are very active, would not be brought out sufficiently in the name. Therefore, in designating such waters the names of such active substances contained in small quantities are joined to the regular class name. For example, waters which contain sulphates in predominating amounts and a small amount of lithium would be termed sulphated saline-lithic waters. Those containing alkaline carbonates and alkaline chlorids in approximately equal quantities and a small amount of bromin would be called alkaline-muriated-saline-bromic waters, etc.

ANALYSIS OF WATER FOR BOILER PURPOSES.

In examining a water for boiler purposes the determination of the ingredients which form a scale or sludge, or act directly upon the iron plates of the boiler, is most important. Waters to be used for boilers are divided into three classes—hard, soft, and saline.

HARD WATERS.

Hard waters contain some or all of the following constituents: Calcium carbonate, magnesium carbonate, and calcium sulphate. The first two of these constituents are held in solution by the presence of carbon dioxid, so that when such waters are boiled and the carbon dioxid is driven off, calcium and magnesium carbonates are precipitated. Therefore, hardness due to these salts can be removed by boiling, and is termed "temporary hardness." When the hardness is due to calcium sulphate, which is not removed by boiling, it is termed "permanent hardness." If the hardness of a water is only temporary it can often be used with fair results, since the two carbonates causing this kind of hardness do not usually form a hard scale, but rather a sludge that can be blown off. In case the temporary hardness is so extreme that the removal of the calcium and magnesium carbonates is necessary, this can easily be effected by treating the water with lime-water or sodium hydrate, either of which joins with the carbon dioxid present in the water, and thus precipitates the carbonates.

Waters, however, that contain calcium sulphate or calcium sulphate and calcium and magnesium carbonates form a hard scale which must be chipped off. This hard scale is due to the presence of calcium sulphate, which is precipitated at the high temperature attained by the water under steam pressure. The evil effects resulting from permanent hardness can be mitigated by treating the water with sodium

carbonate, which forms the less harmful compound, calcium carbonate. It is evident that a scale formed around the boiler will result in the loss of a large amount of heat. It has been found by experience that a one-fourth inch incrustation or scale causes a waste of about 50 per cent of the heat applied.

SOFT WATERS.

Soft waters are those which do not contain a large amount of mineral matter in solution. The only ingredient in waters of this class that is apt to cause trouble is organic matter that may be dissolved as organic acids and corrode the boiler plates.

SALINE WATERS.

Saline waters are those which contain a large amount of salts in solution, but not the incrusting salts. Such waters as these are well exemplified by many of the Western streams and by sea water. When waters containing a very large amount of soluble salts, as the saline waters, are used in a boiler, a point is finally reached when the water deposits its soluble salts. When this point is reached the boiler should be blown off.

There is one ingredient that may occur in any of the above waters, but which most often occurs in the saline waters, that is worthy of attention. This is magnesium chlorid, which, under the great heat that exists in boilers, is acted upon by the water, and magnesium hydroxid and hydrochloric acid are formed. Of course, the hydrochloric acid attacks the boiler plates, while the magnesium hydroxid helps to form a scale.

DETERMINATIONS NECESSARY IN BOILER WATERS.

In making an analysis of a boiler water, therefore, the following determinations are necessary: Carbonic and bicarbonic acids, free acids other than carbonic and bicarbonic acids, chlorin, sulphuric acid, calcium, and magnesium. In order that these bases and acids may be combined as salts according to the usually accepted method, determinations of iron, aluminum, sodium, potassium, and occasionally nitric acid are also necessary. The determination of silica is often included, and sometimes in peaty waters the determination of organic matter.

It is thus evident that in making a water analysis the substances to be determined and the interpretation of the results depend entirely upon the purpose for which the analysis is desired, and that in nearly all cases a history of the water is extremely helpful, while in some cases it is absolutely necessary.

DISTRIBUTION AND MAGNITUDE OF THE POULTRY AND EGG INDUSTRY.

By George Fayette Thompson, M. S.,
Editor, Bureau of Animal Industry.

POULTRY AN ESSENTIAL PART OF FARM STOCK.

Chickens form an essential part of the stock upon many farms. The Twelfth Census shows that there were 5,739,657 farms in the United States in 1900, and it is safe to say that those which did not have chickens among the stock were very few indeed. The census also shows that there were 250,681,593 fowls (chickens, turkeys, geese, and ducks) in the United States. This gives an average of 42 to every farm.

The statistics of this paper, so far as they relate to the poultry of the United States, are principally from the bulletins issued by the Census Office for the several States and Territories. Poultry not on farms is omitted from the census bulletins, hence that on farms only is here considered. The raising of poultry in the villages of the country is a matter of no small consequence, and the totals would no doubt greatly augment the farm totals.

It will be observed that the enumeration of fowls was for the year 1900, having been made in June of that year, while the production of poultry and eggs—that which was sold or reserved for breeding—was for the calendar year 1899. Poultry is sold and eggs are produced during every month of the year, and the calendar year was probably much easier to handle than a fiscal year would have been, as the farmer usually closes his accounts in December, and upon these accounts the census enumerators based their reports; but it would not be a fair showing to the industry to enumerate the fowls on January 1, for the reason that during the calendar year millions of fowls would be hatched and grown into table poultry and consumed, and so never be counted. For purposes of comparison there is practically no difference in this matter between 1899 and 1900.

One of the things that will first attract the attention of one who reviews these statistics is the apparent large decrease in the number of poultry in 1900 from the number in 1890. This decrease is only apparent, not real; for the census enumerators in 1900 were instructed not to take account of fowls under three months old. In 1890 all

fowls, whatever their ages, were enumerated. These facts should be kept in mind in making any comparisons in numbers between the census years. That there was an enormous increase during the decade may be known from the very large increase in the number of eggs produced. For instance, the tables show that in 1890 there were 285,609,440 fowls in the United States and 250,681,593 in 1900—a decrease of about 35 million. The production of eggs, however, amounted to 1,293,818,144 dozen in 1899. This was an increase of 474,095,228 dozen over 1889, and is evidence of a very large increase in the number of fowls.

POULTRY STOCK AND POULTRY PRODUCTS.

The value of all fowls on farms in 1900 was $85,794,996. It is difficult to estimate how much should be deducted from this sum to represent the fowls under the age of three months, but evidently the amount should be considerable. Whatever remains after such a deduction represents quite accurately the poultry stock, that is, that which is kept for breeding and laying. Let us assume that this reduced amount is $70,000,000, which certainly is not too low. Now, we have 250,681,593 fowls, worth $70,000,000, producing for market in one year poultry worth $136,891,877 and eggs worth $144,286,370—a total value of $281,178,247. The investment has yielded an income of 400 per cent! This is not a matter of much astonishment to one who is familiar with poultry raising and has reckoned on the possibilities of the hen. In seeking for the causes of this startling situation one must not overlook the great amount of work done by the mechanical incubator, which is not only as fully successful as the hen, but does its work on a very large scale. The use of the incubator has made it the duty of the hen to devote her whole time to the production of eggs.

In 33 of the States and Territories the value of the eggs exceeds the the value of the poultry product, while in the remaining 19 the reverse is true. The table following shows that in the New England States especially, the eggs greatly outvalue the poultry product:

Value of poultry and egg products in 1899.

State or Territory.	Poultry (value).	Eggs (value).	State or Territory.	Poultry (value).	Eggs (value).
Alabama	$2,263,346	$1,825,978	Georgia	$2,481,610	$1,615,538
Alaska	179	360	Hawaii	61,546	45,257
Arizona	114,884	163,486	Idaho	282,468	465,504
Arkansas	2,179,634	2,328,509	Illinois	11,307,599	8,942,401
California	2,492,067	3,864,679	Indiana	8,172,993	7,441,944
Colorado	587,536	852,978	Indian Territory	647,844	625,418
Connecticut	984,207	1,523,319	Iowa	9,491,819	10,016,707
Delaware	596,391	488,401	Kansas	6,491,183	7,237,111
District of Columbia	5,480	6,492	Kentucky	4,970,063	3,460,607
Florida	574,703	553,524	Louisiana	1,425,116	1,281,713

Value of poultry and egg products in 1899—Continued.

State or Territory.	Poultry (value).	Eggs (value).	State or Territory.	Poultry (value).	Eggs (value).
Maine	$955,468	$2,038,225	Oklahoma	$1,302,460	$1,281,414
Maryland	2,077,490	1,572,682	Oregon	826,687	1,162,071
Massachusetts	1,407,631	2,571,311	Pennsylvania	7,151,243	9,080,725
Michigan	4,551,945	6,104,462	Rhode Island	398,790	656,815
Minnesota	2,927,717	4,437,148	South Carolina	1,539,755	925,966
Mississippi	2,387,484	1,871,765	South Dakota	1,020,382	1,727,392
Missouri	9,525,252	8,315,371	Tennessee	4,282,740	3,115,335
Montana	398,487	631,143	Texas	5,311,362	4,672,187
Nebraska	3,499,044	4,068,002	Utah	262,503	424,628
Nevada	71,175	122,522	Vermont	689,109	959,965
New Hampshire	610,6[illegible]	1,213,763	Virginia	3,744,654	[illegible]
New Jersey	2,265,816	1,938,304	Washington	848,291	1,259,225
New Mexico	[illegible],152	157,175	West Virginia	1,843,752	1,877,[illegible]75
New York	6,161,429	8,630,062	Wisconsin	3,598,427	[illegible]
North Carolina	2,689,970	1,810,116	Wyoming	79,488	163,517
North Dakota	594,751	782,790	Total	136,891,877	144,286,370
Ohio	8,847,009	10,280,769			

Production of eggs in 1879, 1889, and 1899, and price per dozen in 1899.

[Compiled from census reports.]

State or Territory.	Production of eggs in—			Price per dozen, 1899.
	1879.	1889.	1899.	
	Dozen.	*Dozen.*	*Dozen.*	*Cents.*
Alabama	6,761,646	10,823,526	18,778,960	9.7
Alaska				43
Arizona	72,534	204,174	819,507	20
Arkansas	6,610,050	13,371,909	25,694,860	9
California	5,771,323	13,679,423	24,443,540	15.8
Colorado	520,820	2,685,109	5,704,290	15
Connecticut	5,209,661	5,637,590	7,959,430	19
Delaware	1,427,687	2,218,754	3,571,870	13.7
District of Columbia	35,836	48,430	42,580	12.9
Florida	1,024,106	2,788,991	4,214,186	13.1
Georgia	7,126,058	11,522,788	15,505,330	15.4
Hawaii			155,710	29
Idaho	263,731	737,813	2,879,590	16.1
Illinois	35,978,297	60,351,665	86,402,670	10.3
Indiana	28,823,819	48,621,660	70,782,200	10.5
Indian Territory			6,949,640	9
Iowa	32,253,933	69,448,339	99,621,920	10
Kansas	17,432,286	42,584,975	73,190,590	9.9
Kentucky	15,812,205	24,691,437	35,337,340	9.8
Louisiana	3,392,246	5,933,700	12,820,290	10
Maine	7,059,876	9,384,252	13,304,151	15.2
Maryland	4,984,776	8,718,593	12,511,450	12.6
Massachusetts	6,571,553	8,931,398	12,928,630	19.9
Michigan	20,762,171	34,309,633	54,318,410	11.2
Minnesota	8,234,161	20,354,498	43,208,130	10.2
Mississippi	6,364,410	11,393,498	18,942,070	9.8
Missouri	28,352,032	53,147,418	85,203,290	9.8
Montana	208,794	834,166	3,002,890	20.6
Nebraska	7,166,090	23,300,684	41,132,140	9.9

Production of eggs in 1879, 1889, and 1899, and price per dozen in 1899—Continued.

State or Territory.	Production of eggs in—			Price per dozen, 1899.
	1879.	1889.	1899.	
	Dozen.	*Dozen.*	*Dozen.*	*Cents.*
Nevada	120,471	170,725	589,495	20.8
New Hampshire	3,347,211	5,049,150	7,005,180	17.3
New Jersey	6,686,142	8,031,571	11,942,550	16.3
New Mexico	238,858	279,664	839,890	18.7
New York	31,958,739	45,807,106	62,096,690	13.8
North Carolina	7,455,132	11,755,635	17,704,020	10.2
North Dakota [a]	1,012,613	3,552,664	7,438,400	10.5
Ohio	43,092,291	70,162,240	91,766,630	11.1
Oklahoma		989,625	13,724,900	9.3
Oregon	1,654,738	4,453,933	7,709,970	15
Pennsylvania	34,377,889	50,049,915	67,038,180	13.5
Rhode Island	1,564,934	2,020,714	3,217,310	20.4
South Carolina	3,416,846	5,702,141	9,007,760	12.8
South Dakota		8,777,993	17,349,750	9.9
Tennessee	16,317,482	23,172,313	31,807,990	9.8
Texas	11,486,566	32,466,433	58,040,810	7.7
Utah	826,237	1,131,071	3,387,340	12.5
Vermont	3,050,131	4,515,130	6,271,880	13.7
Virginia	8,950,629	13,557,571	25,550,460	11.1
Washington	501,448	2,710,520	7,473,790	16.9
West Virginia	6,741,893	9,919,974	17,242,400	10.9
Wisconsin	15,826,025	29,390,784	46,249,580	10.5
Wyoming	30,740	332,221	937,570	17
Total	456,910,960	819,722,916	1,293,818,144	11.1

[a] Includes Dakota before division into North Dakota and South Dakota.

In the production of eggs Iowa leads, with 99,621,920 dozen, worth \$10,016,707. Ohio comes second as to amount, with 91,766,630 dozen, worth \$10,280,769. It will be observed that, although Iowa had about 8 million dozen of eggs more than Ohio, the value of the product of the latter State was considerably higher. Illinois takes third place for eggs, with 86,402,670 dozen, worth \$8,942,401, and Missouri comes next, with 85,203,290 dozen, worth \$8,315,371.

The table showing the production and price per dozen of eggs, by States, for the years 1879, 1889, and 1899 contains much that is of interest to one who may be inclined to compare different States as to production and price. The highest price realized for eggs per dozen, leaving Alaska and Hawaii out of consideration, is credited to Nevada, the average there being 20.8 cents. Montana was a very close competitor, at the average price of 20.6 cents. Washington comes next, with an average of 16.9 cents. California fourth, with 15.8 cents as an average, and Oregon is fifth, with 15 cents as an average. The lowest price obtained for eggs was 7.7 cents, by Texas. That State disposed of 58,040,810 dozen at this average price.

The average farm price of the 1,293,818,144 dozen of eggs produced in the United States in 1899 was 11.15 cents. The number of eggs per

capita for the same year was 203, and the value of the eggs per capita was $1.89.

Another statement that will, no doubt, come as a surprise to most people is that the egg product of 1899 was valued at a higher figure than the combined gold and silver product of the United States during any year since 1850, except for the one year of 1900, when the precious metals exceeded the eggs by $9,418,125. The same statement is true of the poultry product, if we except the years of 1899 and 1900, when the excesses of gold and silver combined over eggs were, respectively, $4,967,123 and $16,812,618. The surprise occasioned by these figures is still further heightened when we become aware that the poultry and eggs together in 1900 were worth more than either the gold or the silver production of the world for any year since the beginning of records, in 1493, excepting the two years of 1898 and 1899, when the poultry products fell below to the extent of $5,701,453 and $25,990,553, respectively.

Comparisons of this kind are always interesting, and they are also profitable in that they give an adequate conception of the immensity of the poultry industry of the country. Pursuing the comparisons further, therefore, we find that the poultry and eggs of 1899 outvalued the total exports of animals and animal products during all the years down to and including 1900. In 1901 the total exports of animals and animal products amounted to $295,786,642, thus exceeding the poultry and eggs by $14,608,395. These exports, it should be stated, include animals, hoofs, horns, bones, glue, bristles, grease, hair, and hair manufactures, hides and skins, hide cuttings, boots and shoes, leather of all kinds, dairy products, sausage casings, and wool and wool manufactures.

The value of all products of animal origin in 1899 (wool, mohair and goat hair, milk, butter, cheese, eggs, poultry, honey, wax, animals sold, and animals slaughtered) amounted to $1,718,990,221. Poultry and eggs, which formed 16.3 per cent of this great sum, were outvalued by two of these products only—dairy products (milk, butter, and cheese) and animals sold. The item of wool, which is ever a matter of concern in the commercial world and which is so important as sometimes to become the shibboleth of a political campaign, was worth but $45,723,739, being $91,168,138 less than the value of the poultry sold and $98,563,232 less than the worth of the eggs produced, and less than one-third of the value of these two combined. Animals slaughtered on the farms were worth but $52,981,433 more than the poultry product and $45,586,940 more than the eggs produced; but the animals which were slaughtered were worth $91,304,937 less than the poultry and eggs taken together. (See fig. 33.)

The poultry and egg product of 1899 exceeded in value the wheat crop of twenty-eight States and Territories, as follows: Alabama,

Arizona, Arkansas, Connecticut, District of Columbia, Florida, Georgia, Illinois, Indian Territory, Iowa, Louisiana, Maine, Massachusetts, Mississippi, Missouri, New Hampshire, New Jersey, New York, North Carolina, Pennsylvania, Rhode Island, South Carolina, Texas, Vermont, Virginia, West Virginia, Wisconsin, and Wyoming. It was worth more than the corn crop of the following: Arizona, California, Colorado, Connecticut, District of Columbia, Idaho, Maine, Massachu-

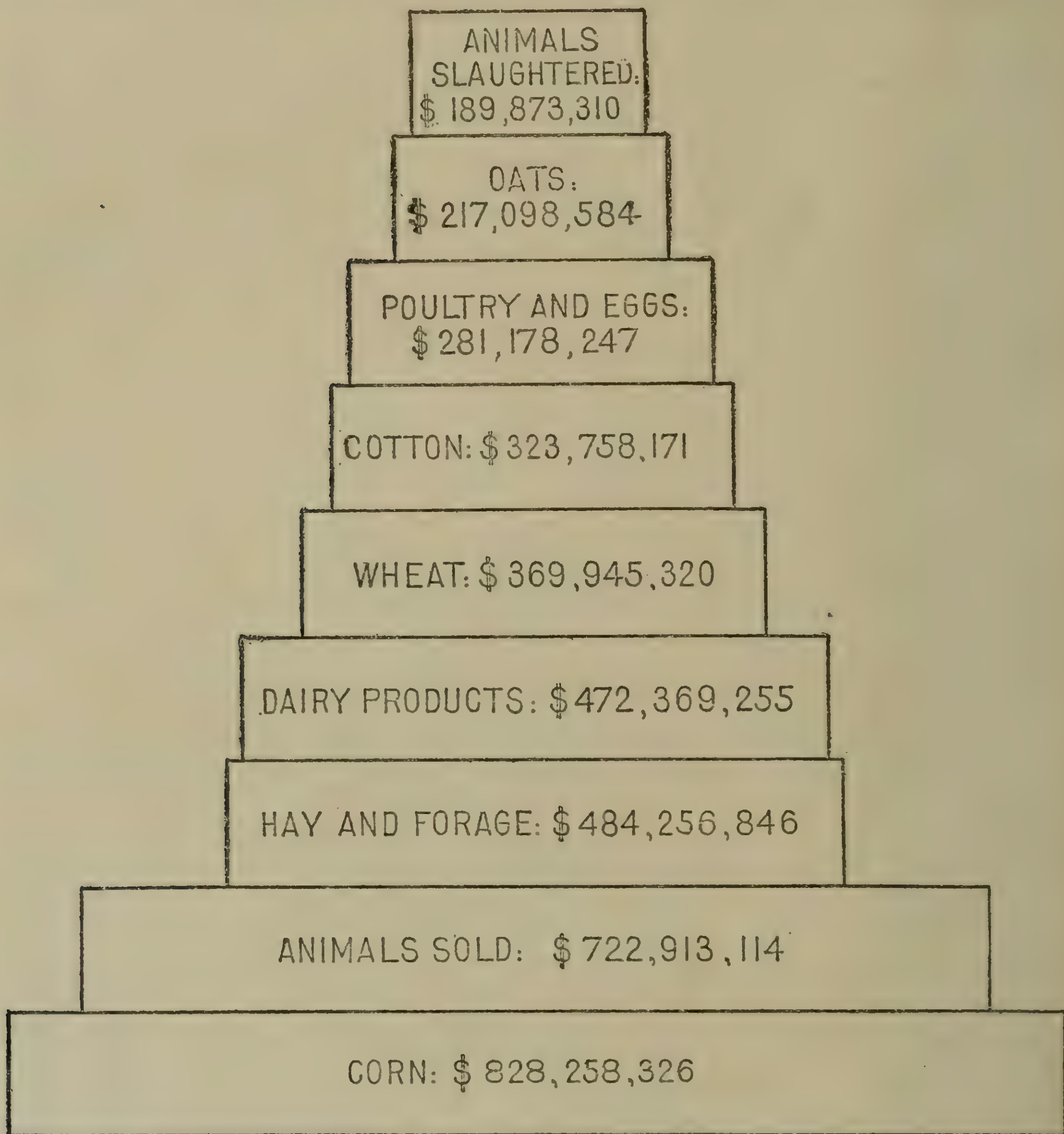


FIG. 33.—Relative position of poultry and eggs among leading farm products in 1899.

setts, Montana, Nevada, New Hampshire, New York, North Dakota, Oregon, Rhode Island, Utah, Vermont, Washington, and Wyoming.

The table shows that there were produced on farms, in 1899, 1,293,818,144 dozen of eggs. This amounts to 43,127,272 crates of 30 dozen each. An ordinary refrigerator car, which has an average length of about 42.5 feet, holds 400 crates. All this means, then, that a train of these cars sufficient to carry the product of 1899 would be 868 miles long, or long enough to reach from Chicago to Washington and have several miles of cars to spare.

TURKEYS, GEESE, AND DUCKS.

While the very large majority of the fowls on farms were chickens, there were enough turkeys, geese, and ducks to demand attention. In 1900 there were 6,599,367 turkeys, 5,676,863 geese, and 4,807,355 ducks, not including any under three months old. Texas leads in the number of turkeys, with 648,671; Illinois is second, with 446,020, and Iowa is a close third, with 424,306. Kentucky leads in the number of geese, having reported 541,576; Missouri reported 428,307; Texas, 415,709; Arkansas, 378,475; Mississippi, 357,963. As to ducks, Iowa takes the lead, with 487,752; then comes in the order given Illinois, with 382,857; Missouri, with 278,140; Texas, with 234,664, and Indiana, with 230,432. The values of these different kinds of poultry are not given separately in the census reports.

It is very seldom that the eggs of the turkey and the goose are found in the markets. Duck eggs are frequently on sale in limited quantities, but they are not so desirable as the hen eggs, although they are larger. This is because of their peculiarly unpleasant flavor, which is said to be due to the character of the food of the duck. Practically all the eggs, therefore, that find their way to market are those of the hen. Turkeys, geese, and ducks are not kept primarily for egg production, but the first for meat and the other two for meat and feathers.

Numbers of fowls, by States and Territories, in 1890 and 1900, and value of same in 1900.

[Compiled from census reports.]

State or Territory.	1890.				
	Chickens.	Turkeys.	Geese.	Ducks.	Total.
Alabama	6,252,044	177,681	381,226	102,850	6,913,801
Alaska					
Arizona	57,224	2,744	157	1,685	61,810
Arkansas	6,264,427	118,816	469,083	195,779	7,048,105
California	3,504,251	287,799	37,659	157,514	3,987,223
Colorado	710,942	20,872	1,096	12,105	745,015
Connecticut	1,075,044	30,176	5,100	31,484	1,141,804
Delaware	900,212	70,578	10,525	50,046	1,031,361
District of Columbia	10,543	215	84	291	11,133
Florida	919,601	34,426	37,502	9,491	1,001,020
Georgia	7,357,934	148,797	291,676	105,537	7,903,944
Hawaii					
Idaho	231,547	6,433	1,447	7,296	246,723
Illinois	21,463,525	1,043,947	725,904	735,660	23,969,036
Indiana	12,307,903	505,111	431,778	348,001	13,595,793
Indian Territory					
Iowa	20,201,706	940,849	261,695	547,023	21,951,273
Kansas	15,843,345	530,397	117,916	485,097	16,976,755
Kentucky	12,740,559	672,106	967,417	370,401	14,750,483
Louisiana	2,246,907	74,680	149,312	67,112	2,538,011
Maine	1,411,185	15,259	7,270	26,947	1,460,661
Maryland	3,430,859	278,522	91,238	232,519	4,033,138
Massachusetts	1,623,605	5,805	8,379	70,593	1,708,382

Number of fowls, by States and Territories, in 1890 and 1900, etc.—Continued.

State or Territory.	1890.				
	Chickens.	Turkeys.	Geese.	Ducks.	Total.
Michigan	5,852,690	185,847	72,898	98,789	6,210,224
Minnesota	4,448,831	151,459	69,224	74,697	4,744,211
Mississippi	5,631,784	194,398	474,688	63,727	6,364,597
Missouri	22,785,848	928,751	849,230	627,959	25,191,788
Montana	233,660	5,077	722	4,193	243,652
Nebraska	7,395,368	218,636	69,839	275,180	7,959,023
Nevada	62,167	4,193	525	2,718	69,603
New Hampshire	934,322	10,207	2,795	17,031	964,355
New Jersey	2,990,698	162,270	20,367	113,668	3,287,003
New Mexico	60,596	928	216	1,104	62,844
New York	8,421,667	402,642	80,403	301,419	9,206,131
North Carolina	7,507,593	197,420	375,991	169,409	8,250,413
North Dakota	804,388	33,928	9,593	11,592	859,501
Ohio	13,659,359	521,171	277,225	409,698	14,867,453
Oklahoma	388,427	5,931	725	4,484	399,567
Oregon	1,180,765	43,555	21,389	32,325	1,278,034
Pennsylvania	10,381,781	535,828	106,538	357,238	11,381,385
Porto Rico					
Rhode Island	482,370	11,656	16,805	13,706	524,537
South Carolina	3,873,798	149,126	121,525	47,099	4,191,548
South Dakota	2,292,866	60,163	22,465	48,632	2,424,126
Tennessee	12,062,139	430,333	778,128	361,984	13,632,584
Texas	11,523,717	535,916	528,149	391,086	12,978,868
Utah	279,983	9,220	1,451	5,655	296,309
Vermont	789,278	72,164	10,838	13,047	885,327
Virginia	6,576,260	477,414	216,175	299,142	7,568,991
Washington	779,972	17,187	5,847	14,122	817,128
West Virginia	3,197,447	214,756	176,723	133,942	3,722,868
Wisconsin	5,646,294	206,230	130,082	91,206	6,073,812
Wyoming	73,694	2,441	155	1,797	78,087
Total	258,871,125	10,754,060	8,440,175	7,544,080	285,609,440

State or Territory.	1900.					
	Chickens.	Turkeys.	Geese.	Ducks.	Total.	Value.
Alabama	4,737,606	129,326	243,657	75,947	5,186,536	$1,409,269
Alaska	176				176	166
Arizona	165,200	6,043	840	2,439	174,522	80,798
Arkansas	5,393,157	140,661	378,475	180,583	6,092,876	1,540,006
California	3,947,200	158,356	28,419	62,293	4,196,268	1,877,489
Colorado	968,761	30,781	2,576	15,002	1,017,120	393,219
Connecticut	1,073,026	7,717	3,530	14,100	1,098,373	644,050
Delaware	628,866	19,045	6,438	10,933	665,282	357,475
District of Columbia	8,001	46	16	227	8,293	3,108
Florida	1,107,816	32,869	36,658	6,877	1,184,220	394,557
Georgia	4,549,144	103,416	208,997	64,895	4,926,452	1,458,055
Hawaii	31,888	4,672	75	21,508	58,143	38,257
Idaho	516,412	10,211	3,850	9,536	540,009	20[illegible],127
Illinois	16,600,728	446,020	307,657	382,857	17,737,262	6,415,083
Indiana	11,103,906	345,379	271,004	230,432	11,949,821	4,222,169
Indian Territory	1,960,505	92,509	77,216	88,069	2,218,299	515,384
Iowa	18,907,673	424,306	223,612	487,752	20,043,343	6,535,464
Kansas	11,966,843	275,330	97,768	216,244	12,556,185	4,356,997
Kentucky	6,849,079	279,749	541,576	185,064	7,855,468	2,723,221

Number of fowls, by States and Territories, in 1890 and 1900, etc.—Continued.

State or Territory.	1900.					
	Chickens.	Turkeys.	Geese.	Ducks.	Total.	Value.
Louisiana	3,890,563	115,921	169,936	123,059	4,299,479	$1,057,889
Maine	1,564,853	6,437	4,566	9,708	1,585,564	756,153
Maryland	2,113,544	101,782	33,389	56,930	2,305,645	1,158,020
Massachusetts	1,625,269	3,018	6,389	46,017	1,680,693	1,018,119
Michigan	8,033,531	191,863	73,267	106,399	8,405,060	2,685,829
Minnesota	7,730,910	193,143	90,975	127,635	8,142,693	2,274,649
Mississippi	5,194,856	189,698	357,963	95,668	5,838,185	1,655,319
Missouri	14,903,601	466,665	428,307	278,140	16,076,713	5,720,359
Montana	531,774	12,637	2,629	[illegible]	[illegible]	[illegible]
Nebraska	7,417,837	118,892	74,007	201,503	7,812,239	2,374,930
Nevada	100,661	3,618	880	2,379	107,538	55,826
New Hampshire	870,461	2,386	1,289	3,803	877,939	467,104
New Jersey	1,993,591	32,378	10,518	40,024	2,076,514	1,360,853
New Mexico	156,853	3,805	830	1,527	163,015	62,419
New York	8,964,736	190,879	45,933	150,864	9,352,412	4,310,755
North Carolina	3,871,858	120,737	284,424	102,942	4,379,961	1,434,158
North Dakota	1,409,205	39,073	17,266	23,816	[illegible]	[illegible]
Ohio	14,269,525	362,924	179,665	206,238	15,018,352	[illegible]
Oklahoma	2,527,353	86,450	12,934	71,562	2,698,299	900,743
Oregon	1,290,818	36,031	26,580	19,774	1,373,203	582,524
Pennsylvania	10,553,106	259,824	60,780	171,271	11,044,981	4,483,486
Porto Rico	....	....	....	....	365,499	....
Rhode Island	500,618	4,604	6,335	8,957	520,514	305,047
South Carolina	2,664,784	120,140	83,543	39,852	2,908,319	889,953
South Dakota	3,028,700	53,740	33,334	62,511	3,178,285	856,966
Tennessee	6,184,210	193,397	391,698	202,432	6,971,737	[illegible]
Texas	13,562,302	648,671	415,709	234,664	14,861,346	3,595,243
Utah	534,842	10,649	2,759	8,503	556,753	186,922
Vermont	806,451	22,689	5,187	8,836	843,163	421,195
Virginia	4,590,311	207,675	125,495	117,989	5,041,470	1,886,768
Washington	1,196,639	29,155	64,488	66,433	1,356,715	614,838
West Virginia	2,759,585	105,265	129,948	58,273	3,053,071	963,805
Wisconsin	8,097,399	155,121	102,224	92,800	8,447,544	2,410,714
Wyoming	142,136	3,664	1,312	2,452	149,564	60,397
Total	233,598,005	6,599,367	5,676,863	4,807,358	250,681,593	85,794,996

ANNUAL CONSUMPTION OF EGGS.

It would be interesting to know how many eggs are consumed annually in the United States, but this is a matter which can not be arrived at definitely. There would, of course, be no difficulty in getting the difference between the total production and the exports, but the number reserved for hatching is an uncertain quantity and very large.

Mr. J. Dixon Avery, of the Chicago Butter and Egg Board, quite recently stated that the people of the United States consume 90 per cent of all the eggs produced. A part of a paper which he read at the time of this estimate is quoted in order to give some insight into the consumption of eggs in cities, especially Chicago and New York:

Of course, no one can get the exact amount of eggs consumed daily any month or any week of the year, but I have succeeded in getting together figures that I think are fairly convincing.

We find that the receipts and consumption of eggs in New York City aggregated last year 2,372,500 cases. Assuming the population of Greater New York to be 3,000,000, we find that each person in New York consumes $\frac{78}{100}$ of an egg daily. Admitting that we consume as many eggs per capita here in Chicago as they do in New York City, and also granting that we have 2,000,000 population here, we find the average daily consumption in Chicago to be 4,333 cases of eggs.

We all know the daily consumption in Chicago to be 4,333 cases. We believe that there is no day in the year that the consumption in Chicago is less than 2,000 cases. We also believe that during the early spring season, or during March and April, the consumption of eggs would be about double the average, or 8,666 cases daily; therefore, we have the two extremes before us—namely, from 2,000 cases to 8,666. I estimate further that there are about four months in the year—namely, May, June, September, and October—that the consumption is about the average per day for the twelve months, and if it is also conceded that the consumption during two of the spring months is double the average, then the daily consumption for the other six months of the year would average from 2,000 to 4,000 cases.

I find the receipts of eggs in Chicago from March 1, 1901, to March 1, 1902, to be 1,888,190 cases, and allowing that the daily consumption is as stated, we consume in this city 1,581,545 cases yearly. Deducting this from the receipts as shown above shows that we ship to various cities, East and West, North and South, 306,645 cases yearly.

Again, referring to the production of eggs in the United States, would say I find by the census report for 1899 that there were produced on the farms and ranches of the United States 43,127,306 cases of eggs, and also find by the same report that the production ten years before, or in 1889, was only 25,324,073 cases. Therefore, the increase in the ten years was 15,803,233 cases, or a little over 58 per cent for the ten years, or something over 5½ per cent for each year. Now, in order to get the production of eggs upon the farms and ranches last year, or two years later than the time the census was taken, we must add 11 per cent to the census report, which would make last year's production upon the farms and ranches 47,871,309 cases, and it seems to me that the production outside of the farms and ranches—namely, in the hamlets, villages, towns, and cities—is at least 2½ per cent of the production upon the farms and ranches. If we add 2½ per cent to these figures, we would have a grand total of 49,068,091 cases as the production for last year.

IMPORTS AND EXPORTS OF EGGS AND POULTRY.

The imports of eggs form an insignificant part of the sum total of our commerce. For the fiscal year ended June 30, 1900, the value of eggs imported was only $8,741; for the fiscal year of 1902, however, a considerable increase is shown, the value being $37,432 for 384,070 dozen. This was at the rate of 9.7 cents per dozen at port of shipment. Records of imports are available since 1862, and these show that there have been years when the value of imported eggs has been quite large. This is especially true of the years 1880 to 1891, inclusive.

The exports of eggs in 1900 (fiscal year) were the largest in the history of the industry, 5,920,727 dozen, valued at $984,081. When the quantity exported is compared with the 1,293,818,144 dozen produced in the census year of 1899, one is impressed with the insignificance of the exports. Such a comparison emphasizes in the most forcible manner the immensity and the consequent value of the home market.

The large majority of the fowls of this country are found in comparatively small numbers on a very large number of farms, where they gather their own subsistence and receive practically no care. The consequence of this is that the eggs are produced at little cost. The development of this industry to an extent incredibly larger than it is at the present time is among the easy possibilities. When this is done there will be produced a surplus which must find an outside market.

A table of imports and exports accompanies this article, giving the statistics for the fiscal years ended June 30, 1862 to 1902, inclusive.

As to the imports and exports of poultry, accurate data are not available. From 1850 to 1883, inclusive, poultry is included in the reports among other animals. From 1884 to 1902, inclusive, the returns appear under the title of "poultry and game." So the figures given in the following table are for poultry and game combined. There does not appear to be any satisfactory method by which one may estimate how much of these exports should be credited to poultry.

Intensive farming is coming more and more into favor as the country becomes more densely populated and as a larger number of farmers adopt scientific methods of practice. The tendency of this is toward the production of more poultry and eggs, and the matter of a foreign market for the surplus will soon come up for settlement.

Value of imports and exports of poultry and game, 1884 to 1902.

Fiscal year.	Imports of poultry and game.	Exports of poultry and game.	Fiscal year.	Imports of poultry and game.	Exports of poultry and game.
1884	$590,791	$69,618	1894	$274,789	$71,880
1885	280,123	97,012	1895	233,416	69,287
1886	338,840	87,315	1896	226,560	80,399
1887	305,402	68,687	1897	211,122	140,853
1888	358,204	67,962	1898	239,681	335,914
1889	392,712	95,968	1899	265,032	505,540
1890	413,491	120,725	1900	311,638	753,399
1891	357,927	34,340	1901	....	1,070,190
1892	307,752	37,989	1902	....	856,801
1893	525,269	61,094			

Quantity and value of imports and exports of eggs, 1862 to 1902.

Fiscal year.	Imports of eggs.		Exports of eggs.	
	Dozen.	*Value.*	*Dozen.*	*Value.*
1862		$90,163		
1863		55,068		
1864		59,980		
1865		121,252		$51,218
1866		187,494	72,114	22,458
1867			31,642	11,329
1868			19,604	5,865
1869		74,589		4,055
1870		13,270	814	322
1871		287,949	5,017	1,428
1872	4,905,423	649,894	5,148	1,018
1873	5,035,577	683,850	15,683	4,169
1874	5,601,175	747,866	23,749	5,239
1875	4,351,810	600,472	34,119	8,743
1876	4,803,771	630,393	29,633	8,300
1877	5,048,271	[a]617,622	32,591	8,429
1878	6,053,619	[b]726,037	94,265	14,880
1879	6,022,506	616,735	91,740	14,250
1880	7,773,492	901,932	85,885	14,148
1881	9,578,071	1,206,067	80,146	13,776
1882	11,929,355	1,808,505	146,776	28,262
1883	15,279,065	2,677,604	360,023	75,080
1884	16,487,204	2,677,360	295,484	62,750
1885	16,098,450	2,476,672	240,768	51,832
1886	16,092,583	2,173,454	252,202	46,105
1887	13,936,054	1,960,396	372,772	60,686
1888	15,642,861	2,312,478	419,701	66,724
1889	15,918,809	2,418,976	548,750	75,936
1890	15,062,796	2,074,912	380,881	58,675
1891	8,926,043	1,185,595	363,116	64,259
1892	4,188,492	522,240	183,063	32,374
1893	3,318,011	392,973	143,489	33,297
1894	1,791,430	199,536	163,061	27,497
1895	2,705,502	324,136	151,007	25,317
1896	947,132	88,682	328,485	48,339
1897	580,681	47,760	1,360,183	189,954
1898	166,319	8,078	2,751,810	448,370
1899	225,180	21,360	3,693,611	611,385
1900	135,038	8,741	5,920,727	984,081
1901	126,520	10,515	3,692,875	676,232
1902	384,070	37,432	2,717,990	528,679

[a] Does not include $2,529, value of condensed eggs.
[b] Does not include $2,213, value of condensed eggs.

An examination of the exports of animals and animal products for the year 1901 shows that the United Kingdom took $181,397,723 worth out of the total of $295,786,642. Previous years show about the same ratio. It is also learned from British reports that the consumption per capita of imported eggs has gradually been on the increase for many years. In looking for an outlet for the surplus eggs

and poultry, it is, therefore, quite natural to consider the possibilities of the United Kingdom for consuming them.

It is an easy matter to show the quantity of eggs imported into the United Kingdom, the quantity reshipped, and the number per capita of the imports, but there are no data at hand to show the extent of English production and consumption. Tables relative to imports are given herewith; they are compiled from the report of the board of agriculture for Great Britain for the year 1901.

The eggs exported from the United Kingdom in 1900 was a small factor in the commerce of that country. The number of dozens was 154,400, and they were valued at $22,220. This was at the rate of 14.4 cents per dozen.

Imports of eggs into the United Kingdom in 1901 were 170,710,000 dozen, valued at $26,745,174, or about 15.6 cents per dozen. The table giving countries from which imports were made shows that Russia was the principal country of supply, with 539,053,000, or 44,921,083 dozen. Belgium, Denmark, and Germany supplied about equal amounts. The imports from the United States amounted to the small sum of 3,426,167 dozen. Belgium, Denmark, Egypt, France, Germany, Morocco, and Russia each sold more eggs to the United Kingdom than did the United States; but it must not be forgotten that it was the demand of the home market that kept the exports of our own country at such a low figure.

Values of poultry and game and eggs imported into the United Kingdom, 1881 to 1901.

Year.	Value of poultry and game.	Value of eggs.	Year.	Value of poultry and game.	Value of eggs.
1881	....	$11,301,911	1892	$2,839,206	$18,467,035
1882	....	11,607 882	1893	2,817,504	18,860,836
1883	....	13,295,516	1894	2,340,232	18,426,170
1884	....	14,163,914	1895	2,915,011	19,482,770
1885	....	14,261,865	1896	3,432,309	20,361,628
1886	$1,712,463	14,035,293	1897	3,556,073	21,202,401
1887	1,995,722	15,016,467	1898	3,102,355	21,690,560
1888	1,963,813	15,004,232	1899	3,821,633	24,548,582
1889	2,302,794	15,220,417	1900	4,916,961	26,308,396
1890	2,422,821	16,686,384	1901	4,772,766	26,745,194
1891	2,223,888	17,059,623			

Imports of eggs into the United Kingdom in 1901, by countries.

Country.	Eggs.	Country.	Eggs.
	Dozen.		*Dozen.*
Argentina	2,417	Sweden	166,167
Belgium	25,756,417	Turkey	11,417
Denmark	30,194,167	United States	3,426,167
Egypt	4,264,083	British possessions:	
France	18,061,742	Canada	703,500
Germany	29,719,833	Channel Islands	1,667
Holland	1,246,833	Gibraltar	36,083
Italy	1,000	Malta	9,000
Morocco	4,184,750	Newfoundland	1,333
Norway	8,583	New Zealand	833
Portugal	817,667	Total	170,710,600
Russia	41,921,083		
Spain	926,500		

It is interesting to note that the per capita consumption of eggs imported into the United Kingdom in 1901 was 49. In 1881 the number consumed per capita was 22, and since that year the number has gradually increased till it reached 49 in 1900 and 1901.

THE INFLUENCE OF FORESTRY UPON THE LUMBER INDUSTRY.

By Overton W. Price,
Assistant Forester, Bureau of Forestry.

DEVELOPMENT OF THE LUMBER INDUSTRY.

The development of the lumber industry in this country is without parallel. It now ranks fourth among the great manufacturing industries of the United States, and represents an invested capital of about $611,000,000 and an annual outlay of over $100,000,000 in wages. It affords through its three great branches—the logging industry, the sawmill industry, and the planing-mill industry—a means of livelihood to considerably over a million persons. The annual value of the products, which has multiplied nearly ten times in the last half century, is $566,000,000. But although the rapid development of the lumber industry has had far-reaching results in furthering every branch of manufacture which depends upon wood, it has been fundamentally unsound in principle. The settler who cuts and sells trees without forethought from land fit only for forest growth has not enriched himself in the long run. The havoc which has been wrought in the forests of the United States has turned trees into money, but has put the balance on the wrong side of the sheet by rendering vast areas unproductive. It is the history of all great industries directed by private interests that the necessity for modification is not seen until the harm has been done and its results are felt. This fact has been emphasized in the lumber industry—in the earlier days by the instinctive feeling of the colonist against his natural enemy, the forest, and later by the remarkable inducements offered by lumbering for present profit only. The first settlers had two objects in view in their attack upon the forest—the one to clear land for their farms, the other to procure wood for their buildings, fuel, and fences. As the tide of colonization rose, and as the uses for wood in manufacture increased in number and extent, lumbering rapidly assumed the proportions of a business enterprise, and from supplying only personal wants it became profitable to supply also those of others. With an apparently inexhaustible supply of timber available, and with an insistent and growing demand, the lumber industry came to offer remarkable opportunities for money making. Step by step with its development improvement in tools and machinery took place. The changes that enterprise and ingenuity have wrought in the American sawmill are no less wonderful than those which have taken place in the

American locomotive. From "whip sawing," in which the boards were sawed out by hand, to the modern steam sawmill, with its railroad (Pl. XXX), its planing mill, and its cut of nearly half a million board feet per day, is a long step—but it has not taken much over fifty years to accomplish it. In effective methods for the harvesting and manufacture of lumber the American lumberman has no superior, nor is he equaled in his disregard for the future of the forest which he cuts.

SOME RESULTS TO BE SECURED BY CONSERVATIVE LUMBERING.

It is natural that the lumberman should not turn eagerly from a system whose only aim is to secure the highest possible present profit from the forest to one which includes provisions for the production of a second crop upon the lumbered area. Under conservative methods lumbering becomes a legitimate industry for the production as well as for the consumption of its staple. It no longer offers, however, the short cut to fortune which it proved to be so long as an abundance of timber rendered the old methods of lumbering possible. It is difficult for lumbermen generally to realize that the time for practical forestry has fully arrived. But signs more significant than any existing statistics point to the imminent failure in the supply of certain timbers in the United States. From the data available, there is no way to foretell accurately the time necessary to exhaust this supply of merchantable timber at the present rate of consumption. A good many estimates of the merchantable timber standing have been made, some of which have already proved fallacious. To predict accurately how long it will be before the United States is confronted by a timber famine would require first of all a knowledge of the composition, quality, and condition of the forests, which it would take many years to obtain. At present such an estimate is of little practical value. We do know that the supply of timber of many kinds is failing, of other kinds is almost exhausted, and of others is practically gone; that Black Walnut is no more to be had except in small quantities and at enormous expense; that first-growth White Pine is growing rapidly to be a rarity on the market; that where the supply of spruce for pulpwood and for lumber for the next ten years is to be found is a grave question before the lumbermen to-day. The list of woods accepted as merchantable lengthens from year to year, species hitherto considered valueless being harvested more and more willingly as the result of the exhaustion of more valuable kinds. In spite of steady improvement in tools, logging outfits, and mill machinery, all tending to cheapen the cost of lumbering, the price of lumber increases steadily and rapidly. These are facts more significant than predictions in terms of years of the life of the lumber industry. The exact period for which the existing supplies are sufficient is a matter of

FIG. 1.—WHIP SAWING IN THE KENTUCKY MOUNTAINS.

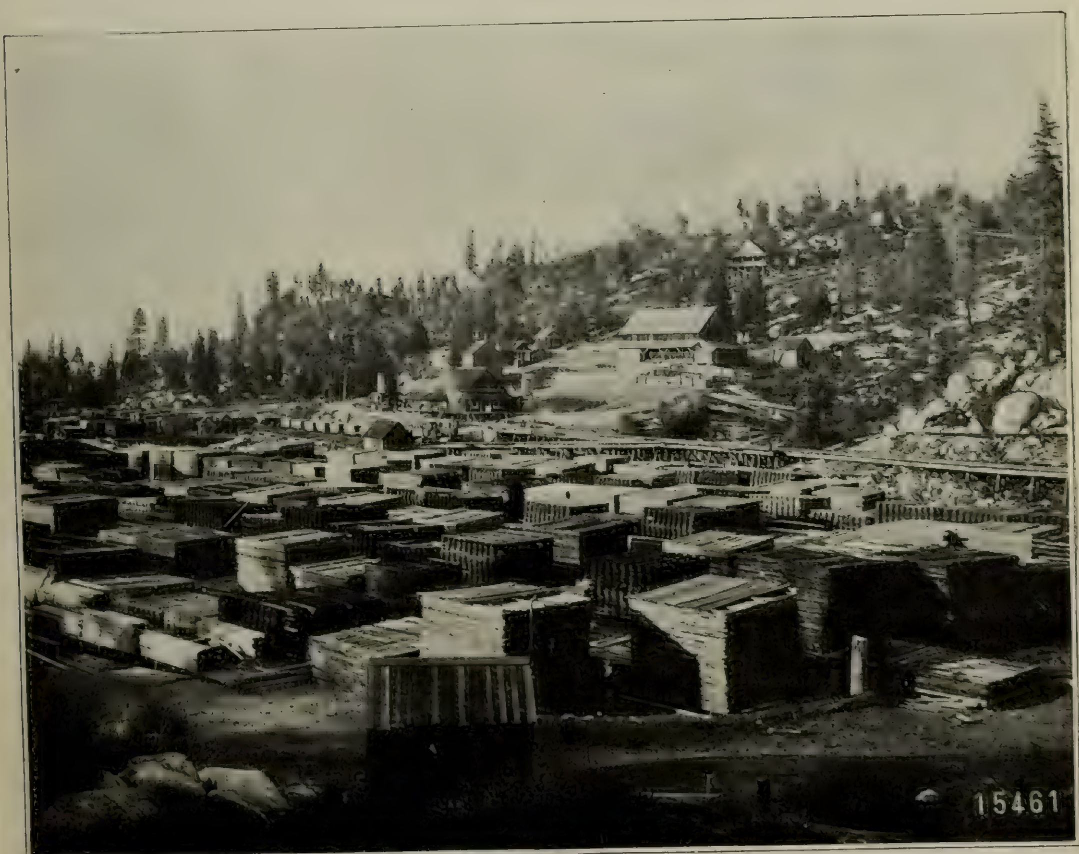
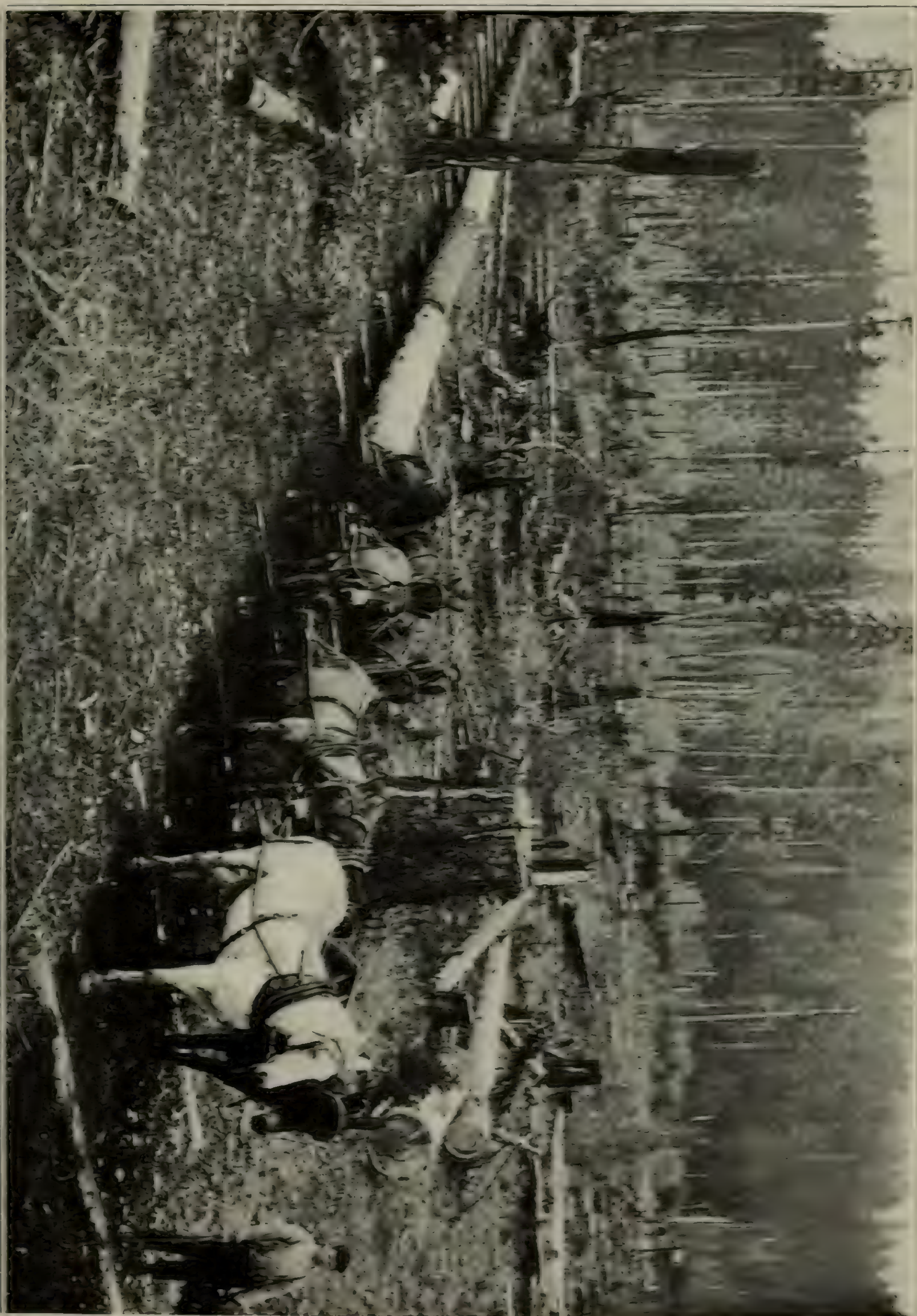


FIG. 2.—A MODERN SAWMILL IN THE SIERRAS, CALIFORNIA.



CUT-OVER RED FIR LAND.

FIG. 1.—THE RESULT OF LUMBERING AND FIRE IN MINNESOTA.

FIG. 2.—LOGGING RED FIR IN WASHINGTON.

detail. The vital point lies in the crisis which the lumber industry is approaching in the exhaustion of the material on which its existence depends. (See Pls. XXXI and XXXII.)

ELIMINATION OF THE LARGE SAWMILL.

The general application of forestry to forest lands owned by lumbermen will probably result in the gradual elimination of the large sawmill and the substitution of those of moderate size. The mammoth milling plant will be rare when only second growth is left to supply it, for the area of timber land sufficient to produce the logs necessary to run such a plant is enormous. It is reasonable to expect that the mill of moderate size, supplied by a forest whose production is equal to the mill's annual capacity, both under the same management, will become more and more the rule. The very existence of the enormous mill is the result of an abundance of timber resources, which exist no longer except in a very few sections. In Europe the long-continued application of conservative measures in lumbering has resulted in a distribution and type of sawmill little known in this country. Sawmills of large size do not exist, but in their stead small sawmills, for which water generally supplies the power, are distributed throughout the country wherever the local demand is sufficient to keep them running. Their annual cut is for the most part exceedingly small, according to our standards, and sufficient only to supply the wants of the immediately adjacent country. The mills saw largely on order, and the fact that their construction is permanent and their motive power cheap enables them to run intermittently without loss. The results are upon the whole exceedingly satisfactory. The man who wants lumber gets it promptly, and without paying an added cost for long transportation. The antiquated construction of European sawmills is often such that the American lumberman would find in them but a proof of his superior ingenuity; but the European distribution of milling plants has its strong advantages in several ways.

DEVELOPMENT OF A TRAINED CLASS OF FOREST WORKERS.

The general application of conservative methods in lumbering will inevitably result, as has been the case in Europe, in the development of a permanent class of men trained to forest work. Under present methods this result can never be attained to the same degree. The lumbering in one community is generally so short-lived that there is neither time nor necessity to train up a body of men on the ground to carry out the work. The result is that Maine and Michigan woodsmen are found working in the hardwoods of the Southern Appalachians; loggers from Wisconsin and Minnesota are helping to cut the redwood on the Pacific coast; and in each of the great timber regions there is a mingling of lumbermen from several of the others. The effect has been to develop, by constant labor at their trade under widely varying

conditions, a force of men who are unequaled for enterprise and skill in their profession; but the system has very largely failed in what is of infinitely greater importance to the permanent welfare of the lumber industry—the upbuilding throughout the country of a stable class of workers in the woods, locally trained and carrying on their work each in his own community. The advantages of such a condition lie in an equitable geographical distribution of labor, in the wholesome influence throughout the country of a class whose means of livelihood is forest work, and in the fact that all the operations of lumbering may in this way be conducted more cheaply than in any other.

INFLUENCE OF FORESTRY UPON THE PRICES OF LUMBER.

The effect upon the prices of lumber which will result from the application of forestry to the lumber industry will be strongly marked. The wide fluctuation characteristic of lumber values to-day is much more the result of conditions within the industry itself than of variations in the demand for the product of the forest. The uncertainty of available supplies, the lack of true proportion between stumpage values and lumber values, the speculative features which the industry now presents, have all tended to produce an exceedingly unstable and abnormal fluctuation in the prices of lumber, with a marked disposition toward rapid increase. Under forestry the speculative element can not exist. The cost of producing timber, plus a legitimate profit, will be the basis upon which the value of it will be fixed. The annual output of the country will be no longer a matter of conjecture, and a steady and normal range of prices for lumber will be the inevitable result.

CONCLUSION.

The influence of forestry upon the lumber industry is not a matter of conjecture. The details will have to work themselves out, but the broad results of conservative forest policy on the part of private owners are plain. The lumber industry in the United States is approaching a crisis. There is no more doubt that conservative methods will be applied to lumbering in this country than there is of the development of irrigation, of regulation of grazing, of the application of improved methods in agriculture, or of any other modification to which private as well as public interests point the way. How long it will be before the results of practical forestry make themselves generally felt it is impossible to foretell; but the fact remains that there will be established in this as in other countries in which conservative lumbering has followed wasteful lumbering a legitimate and permanent industry, characterized, as has been stated, by conditions under which speculation can not exist. Prices will continue normal and steady, and the quantity of timber produced will be the main factor in regulating consumption.

THE AGAVES, A REMARKABLE GROUP OF USEFUL PLANTS.

By E. W. Nelson,

Field Naturalist, Biological Survey.

GENERAL NOTES.

The early explorations in America brought to the attention of Europeans various novel forms of plant life which were utilized by the Indians for food or in their primitive industries. Some of these plants were found in the wilderness, where the natives searched for their products at the proper season; others had become of such importance and value that they were cultivated in a crude way over large areas. The European colonists, recognizing their utility, developed several of these plants, the most notable of which, for the part it has played in the early settlement and subsequent growth of America, is indian corn.

Among the many strange and interesting plants found in the Mexican wonderland by Cortez and his followers were those forming the group variously known to-day as Century-plants, Agaves, or Magueys, one of the most remarkable groups of the plant world. Humboldt considered the Agaves, next to maize and potatoes, the most useful of the natural products of tropical America. They are placed by botanists in the genus *Agave* of the Amaryllidaceæ, a family closely related to the lilies.

CHARACTER AND DISTRIBUTION OF AGAVES.

The Agaves are natives of America, where they occur from southern Nevada, Utah, and Texas, south through Mexico and Central America into Brazil. Their strongly individualized and picturesque character renders them especially interesting for decorative purposes, and the early botanical travelers, sent to gather strange plants for European commercial gardens, brought home numerous species for propagation, which were distributed to various parts of Europe. Many of these were new to science and attracted the attention of botanists, who gave them names, but were usually unable to state definitely the place of origin of the species described. Others have been described from herbarium specimens, often with an equal lack of information as to the region whence they came. The result is a multitude of named species with but little definite information of the distribution of

more than a very few. Dr. J. N. Rose, probably the best American authority on these plants, estimates that there are about 150 recognizable species now known in the genus *Agave*, although botanists have bestowed upon them more than twice that number of names. From present knowledge of the group, however, it is safe to predict that future study will demonstrate the existence of many more species. Agaves are most numerous, both in species and individuals, in the arid and semiarid parts of the table-land of Mexico and adjacent mountain slopes. Their center of abundance is in the Austral life zones between the altitudes of 2,000 and 8,000 feet; still some species thrive on the low coastal plains of the Tropics, and others on the rugged crests of desert mountains in the Transition zone, from 8,000 to 10,000 feet above the sea. During the summer of 1902 the writer found a sturdy species similar to *Agave wislizeni* in rocky places among the firs and pines at an altitude of 10,000 feet in the State of Coahuila, Mexico.

The geological formation has a direct influence on the growth and abundance of Agaves. Limestone areas, where the bed rock is exposed in many places, and has only a thin cap of soil when covered, appears to be most favorable to their development. In Mexico and the Southwestern United States are vast limestone areas, especially in Yucatan and the plains and mountains of the northeastern part of the Mexican table-land and western Texas. In many parts of these areas various species of Agave often grow in such thorny abundance that it is difficult to pick one's way among them. Mr. Vernon Bailey has estimated that about 20,000 square miles of limestone territory in western Texas is covered more or less abundantly with the small *Agave lecheguilla*.

Second in importance to limestone in its influence on the growth and distribution of Agaves are volcanic formations such as are seen about the southern end of the Mexican table-land.

All Agaves require years for their development before flowering, and this has given rise to the popular name "Century-plant," borne by *Agave americana;* but it is doubtful if any species under natural conditions actually spends more than fifteen or twenty years in maturing.

The Century-plant (*Agave americana*) may be taken as a typical member of the genus, though there are numerous modifications of this type among the many known species. Practically all agree in having more or less rigid leaves, each broadly attached at the base and terminating in a strong, horny spine. The leaves vary greatly. In some species they are long and slender, with smooth edges; in others long and fleshy, with heavy, recurved claw-like spines set at short intervals along their borders; and in others short, broad, and still more formidably armed with spines. These armed leaves, clustered about

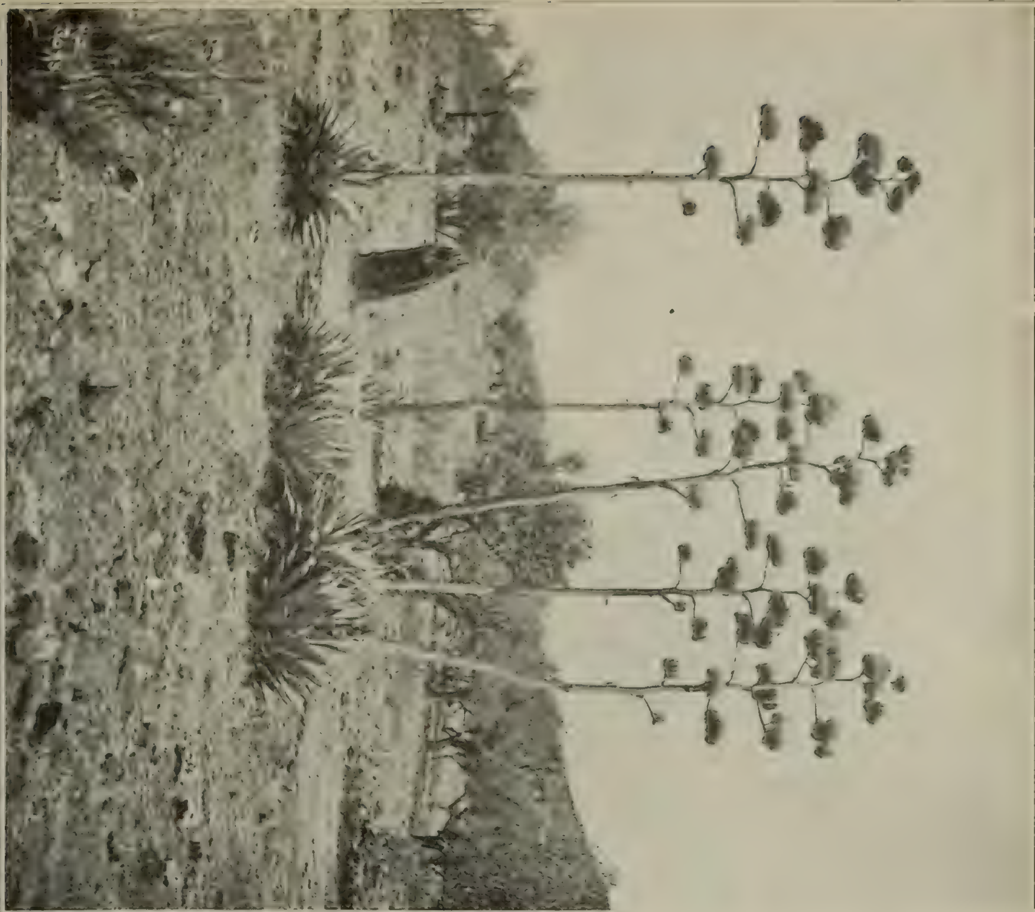


FIG. 1.—GROUP OF AGAVE WISLIZENI, WESTERN TEXAS.

FIG. 2.—PULQUE GATHERER, VALLEY OF MEXICO.

the base of the plant, bristle threateningly at all comers, and serve forcefully to protect the tender tips of the budding flower stalks that might otherwise furnish tidbits to hungry rabbits and ruminants. The puncture made by the stout spine at the end of the leaf is very painful. When, in addition to this terminal spine, the leaves of a large plant have their sides thickly set with strong, claw-like thorns, the protection they afford becomes very evident to the plant collector who tries to reach the flower stem without first cutting away the outer leaves.

PRINCIPAL TYPES OF AGAVES.

There are four principal types of development among these plants: (1) *Agave wislizeni* (Pl. XXXIII, fig. 1), with short, broad leaves, found in the mountains of western Texas; (2) the tequila plant of Jalisco, with large, fleshy base bearing numerous long, slender leaves; (3) the Sisal Agave of Yucatan, with yucca-like trunk; and, (4) a form found on the Mexican table-land, characterized by the development of large, fleshy leaves on a comparatively small base.

The most striking member of the last-mentioned type is the huge Pulque Maguey, the giant of the entire group, which thrives best between 6,000 and 8,000 feet above sea level on the semiarid plains of the southern half of the Mexican table-land. It reaches its greatest development in Toluca Valley and the valley of Mexico, where the huge, fleshy leaves are sometimes 9 feet long and weigh over 100 pounds each, though usually much smaller. Every plant bears from 25 to 50 leaves around a massive, fleshy base, and the largest plants weigh from 1 to 2 tons each.

THE PULQUE MAGUEY.

Pulque, the national drink of the Mexicans, is made from the juice or sap of the Pulque Maguey. The valley of Mexico is the center of cultivation of this plant, and many extensive haciendas or plantations that are devoted entirely to growing it yield large revenues to their owners. The plants when two or three years old are set out in long, parallel rows; they reach maturity in from twelve to fourteen years. In order to insure a succession of harvests, new settings are planted yearly, and even with the long delay in the first crop the business is very profitable. The large, fleshy leaves, as in other members of this genus, are persistent, and spend all the years of their immaturity in slowly storing up quantities of sweet sap. At the expiration of this long period, which might almost be called a period of incubation, a change occurs in the plant's organism. It has attained the supreme moment toward which all the hoarding of sap during the past years has been directed; the character of its activity changes, and with marvelous rapidity a gigantic central flower stalk shoots up 20 to 50 feet. This stalk, which is sometimes a foot in diameter at the

base, is fed generously from the store of sap in the base and leaves. Its upper end branches like a candelabrum, and greenish-white flowers spring forth in palmated clusters. Hummingbirds, orioles, and various insects, attracted by the nectar of the blossoms, pass from plant to plant, and thus insure fertilization, the object of the plant's existence. After the seeds form, the leaves and base, having exhausted themselves in this final effort, wither and die.

On the pulque plantations the plant is not permitted to run its natural course, but is subjected to special treatment. Pl. XXXIII, fig. 2, shows the process of collecting and transporting the juice of the pulque by gatherers, who every day or two for several months visit the tapped plants.

The value of the total product of pulque amounts to millions of dollars annually.

The Pulque Maguey is also commonly set out as a hedge about fields and gardens and its sap gathered for family consumption. This mode of cultivation is shown on Pl. XXXIV.

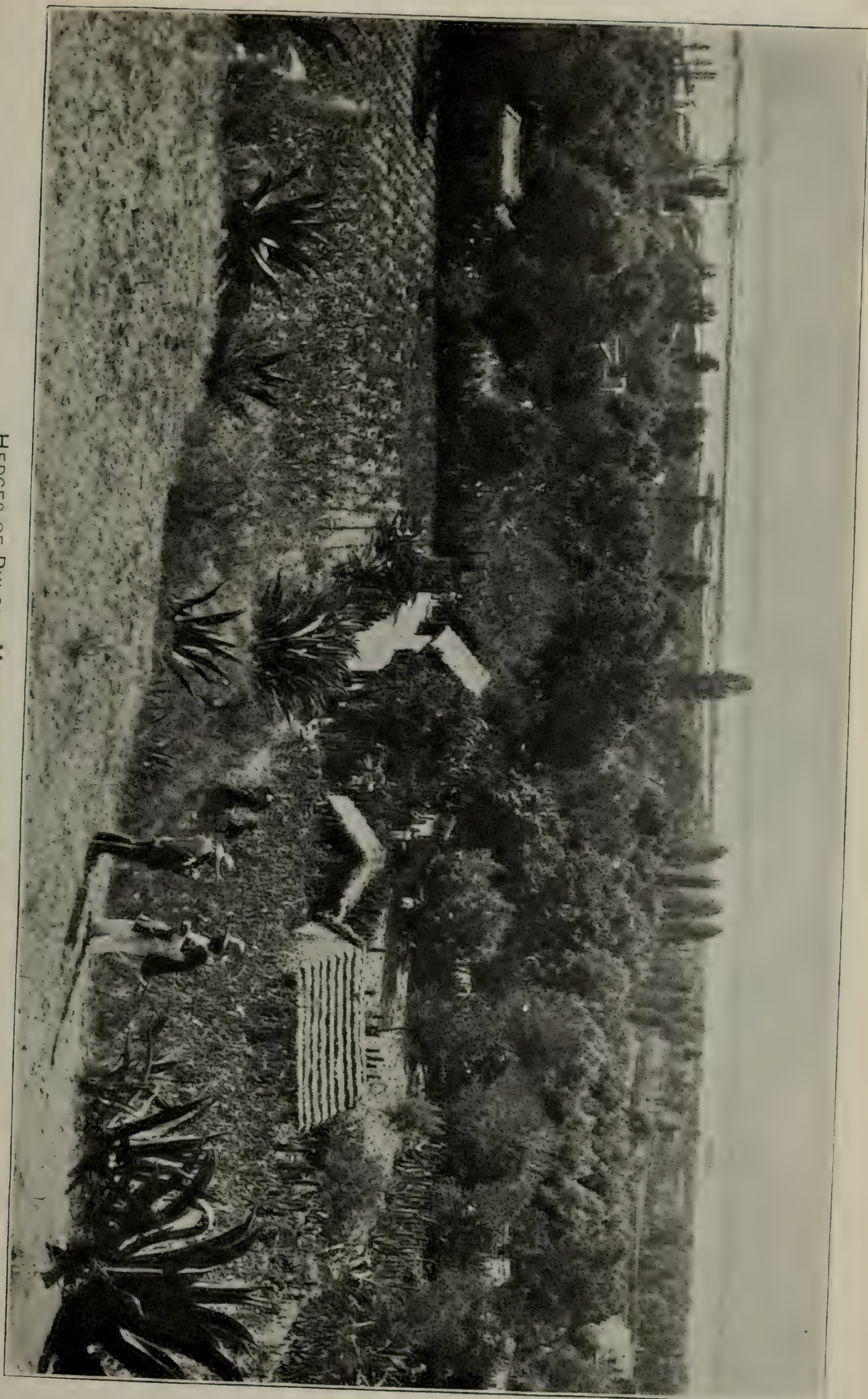
THE MESCAL.

In addition to the species of Agave that yield pulque, a number are utilized to produce distilled alcoholic liquors of different kinds. An alcoholic drink common in Mexico, the product of the Agave, is known as "mescal."

Other liquors distilled from various species of the Mescal Agave are known as "tequila," "huila," and "comiteco." Pl. XXXV shows a tequila plantation and the manner of transporting the fleshy bases of the plant.

USE OF AGAVES AS FOOD.

So far in the story of these plants there has been room for question as to their ultimate benefit to mankind. There is no doubt, however, concerning the usefulness of certain other members of the genus. The fleshy bases of numerous species of Agave are roasted and eaten by Indians and mountaineers both in Mexico and the Southwestern United States. Several of the six species growing wild in southern Nevada, Arizona, New Mexico, and Texas have been well known to the Indian tribes of that region from time immemorial, and still retain the Mexican name "Mescal," whence was derived the name of the Mescalero Apaches of southern New Mexico. The fleshy bases of the mescal are prepared for food in practically the same manner both in Mexico and the United States. Mescal "pits" are made by heaping up masses of Agave bases with fuel and covering them with stones and earth, much in the form of charcoal pits, after which the mass is fired. The slow roasting which results lasts from one to three days and brings about certain changes. The fleshy substance becomes sweet,



HEDGES OF PULQUE MAGUEY, VALLEY OF MEXICO.

FIG. 1.—TEQUILA PLANTATION, JALISCO, MEXICO

FIG. 2.—MULE TRAIN CARRYING BASES OF TEQUILA AGAVE TO DISTILLERY, JALISCO, MEXICO.

and the heart of the plant tender, with much the taste and consistency of an artichoke. Sometimes a shallow pit is dug and lined with stones, which are thoroughly heated by building a fire on top of them. The bases of the Agaves are then freed from their leaves and placed on the stones, a fire is built over them, which, when well started, is covered with earth, and they are left to roast. Roasted mescal is still commonly sold in the market places of small towns over a large part of Mexico and to some extent among Mexicans in towns along the southwestern border of the United States.

MISCELLANEOUS USES OF AGAVES.

The juice of the young leaves of some species is acrid and a mild irritant, and the fresh pulp applied to the skin produces an irritation similar to that of a weak mustard plaster. In ancient times the fresh juice was used to cauterize and cleanse wounds.

The strong terminal thorns of some species were used by the Aztec priests to pierce their tongues, ears, and other parts during certain rites of expiation. The slender flower stalks formerly served for lance shafts, and the large ones are still used by the natives as rafters for their small houses and for fences. The large hollowed leaves are frequently employed to thatch the huts of the poor, both in the country and about the borders of towns.

A number of species of Agaves, known as "Amoles," contain such an abundant supply of saponin that the fleshy parts of the leaves, bases, and sometimes of the roots when rubbed up in water make a good lather and serve excellently for soap. This substance is a satisfactory emollient to the skin, and the Mexican women prize it for washing their hair, which it makes both soft and glossy. It has already entered into the composition of a manufactured hair wash, and efforts have been made to make a soap from it. It is free from alkali, removes stains from delicate fabrics, is said to set colors, and does not shrink flannels like ordinary soap. In southern Arizona *Agave schotti* is the main soap-yielding species, and its properties are well known to the Mexicans of the region, who also call it "Amole."

The Aztecs also utilized the Agave leaves for making a tough paper, upon long, narrow sheets of which were painted in brilliant colors their pictured historical records. Some of these records, known as codices, still exist in collections, and both the colors and paper appear to be little affected by the lapse of the centuries since they were made. The paper of the Aztecs is of a dingy color, but in 1854 a company in Mexico succeeded in making from the Agave leaves a great variety of papers, from the coarsest cardboard to the finest white letter paper, all characterized by unusual toughness and durability, some grades almost equaling parchment in this respect.

TEXTILE PRODUCTS FROM AGAVES.

All Agaves have series of long, slender fibers extending in a thin longitudinal layer just under the surface of each leaf, and centering in the strong horny spine at the tip. The writer has at various times seen the natives, when wishing to hastily repair a coarse garment or sacking, break loose this thorny point of an Agave leaf, and, stripping it away with some of the attached fibers, thus provide themselves with a stout, ready-made needle all threaded for use. The length, strength, quantity, and quality of this fiber varies greatly in different species. The length of the fiber in each case is governed by the length of the leaf. The fibers of the Pulque Maguey are small in quantity and not very strong, but are very long, soft, and silky in texture. They were woven by the Aztecs into soft, delicate garments for the nobles. These garments were often brilliantly colored with native dyes and handsomely embroidered, and their fineness and beauty excited the admiration of the early Spanish invaders.

The uses of Agave fiber among the Mexicans have come down as an inheritance from prehistoric times. Each community knows perfectly the quality of fiber yielded by every kind of Agave growing in its district, and the ranchmen and villagers gather from the wild plants on the surrounding hills the material for their cords, ropes, sacking, and a variety of other articles. The articles made in excess of local demand are taken to market in the larger villages, and form one of the regular but small sources of income to the natives. In some districts, where the wild agaves yield a specially good quality of fiber, the outside demand for the product has created local industries of some importance. Usually products of this kind are in the hands of scattered individuals, mainly Indians, who work in the crudest manner, but in many places the industry has a larger growth under direction of the owners of haciendas, who thus add materially to the revenues of their possessions.

The best fiber-producing Agaves grow in districts where the geological formation is wholly limestone, and often on areas where the underlying rock is covered with barely enough soil to give the plants foothold. The only two districts in Mexico where Agaves are cultivated extensively for their fiber—Tamaulipas and Yucatan—are of this character, the underlying limestone outcropping at short intervals and at best only thinly covered with soil. The first of these areas is situated at an altitude of between 1,500 and 5,000 feet above sea level in western Tamaulipas, and covers the valleys of Jaumave and Tula. It annually exports through the port of Tampico to the United States nearly $500,000 worth of the fiber, which is obtained partly from a wild Agave (*Agave heteracantha*) growing on the sloping borders of the valley and partly from a similar plant cultivated in the valley

FIG. 1.—CUTTING LEAVES OF SISAL AGAVE IN YUCATAN, MEXICO.

FIG. 2.—DRYING SISAL FIBER AT STRIPPING MILL, NEAR MERIDA, YUCATAN, MEXICO.

bottoms, which reaches a much larger size. The fiber from this district is called "ixtle," and is packed on mules to the nearest railroad point for shipment to the coast.

Yucatan is the main center of production for Agave fibers in Mexico. The peninsula of Yucatan is a limestone plain but little above sea level and with a thin covering of soil. On this thrives *Agave sisalana*, the plant which yields the "sisal," "sisal hemp," or "hennequin" of commerce. This is cultivated on large plantations, which, under present conditions, are enormously profitable to their owners. Pl. XXXVI, fig. 1, shows the Indian workmen cutting the fiber-bearing leaves of the sisal on a plantation near Merida, the capital of Yucatan. Yucatan now exports annually about $12,000,000 worth of this fiber to this country, and the amount is steadily increasing. The climate of the peninsula in the sisal district is arid tropical, and the country, though its extremely rocky character renders it almost worthless for any other crop, from this source alone is rapidly becoming, in proportion to its population, one of the richest sections of Mexico. Some ingenious machinery has been invented for stripping the fleshy pulp from the fiber of the leaves. Pl. XXXVI, fig. 2, shows the freshly cleaned fiber lying on drying frames at one of the stripping mills on a plantation near the city of Merida.

The success of the cultivation of the Yucatan Agave has led to its introduction into the Bahamas and some of the West Indian islands. Over sixty years ago it was introduced into southern Florida by Dr. Perrine, American consul at Campeche, who tried to acclimatize useful tropical plants in this extreme southern part of the United States. More recently it is reported that efforts are being made to introduce it into the State of Tamaulipas, Mexico. Yucatan lies below the frost line, and it is a question whether the Agave of that region will prove hardy enough to grow within a frost-visited area. But the "lecheguilla," as the Agave that produces the ixtle fiber of western Tamaulipas is called (probably a distinct species from the *Agave lecheguilla* of Texas), is hardy enough to withstand sharp frosts, and thrives naturally on land practically worthless for other purposes. It is quite possible that it might be profitably grown on land not otherwise available for agriculture in the large area in western Texas where the *Agave lecheguilla* is found, or in other sections of some of the southwestern border States. It may be that the native plant, the *Agave lecheguilla*, which has a shorter, coarser fiber of unknown value, would repay exploitation. The enormous increase during recent years in the value of the Mexican fiber product from this source, with its main market in the United States, appears to justify experiments in the introduction of some of the species of demonstrated value.

CONCLUSION.

By way of conclusion of this brief account of the Agaves, it may be stated that their varied employment for food, drink, soap, clothing, cordage, needles and thread, paper, parts of dwellings, parts of weapons, sacrificial implements, medicaments, and ornamental garden plants amply justifies Humboldt's estimate of their usefulness to mankind.

CHEMICAL STUDIES OF SOME FOREST PRODUCTS OF ECONOMIC IMPORTANCE.

By William H. Krug,
Chief of Dendro-Chemical Laboratory.

Introduction.

A review of the literature devoted specifically to the chemistry of forest products shows that this extensive branch of chemistry has only within comparatively recent years received the attention which it manifestly deserves in view of the commercial importance of the numerous substances derived from trees, among which may be mentioned the various tanning materials, resins, gums, balsams, glucosidal and alkaloidal principles, and the products obtained by the application of chemical processes, such as wood pulps, oxalic acid, methyl alcohol, and acetic acid.

The importance of a systematic investigation of the many problems still demanding solution has resulted in the establishment of a laboratory in the Department of Agriculture, which is to be conducted in collaboration between the Bureau of Forestry and the Bureau of Chemistry, and is designed to extend its operations to this field.

Composition of American Woods and Barks.

One of the first investigations which was suggested, and which was believed to be important, owing to the lack of sufficient data on the subject, was a study of the chemical composition of the wood and bark of various native trees. It is naturally evident that an investigation of this kind is of such magnitude that it can not well be completed for some time, and the work has so far been limited to a number of American oaks and the Western Hemlock. The specimens were collected by the field assistants of the Bureau of Forestry, and trees of different ages were chosen, disks being cut at definite distances from the ground to the base of the crown. The analytical work included, whenever possible, analyses of the sap, middle, and heart woods, and in the hemlocks, of the wood and bark of the north and south sides of the tree, for the purpose of determining variations in composition, if such existed.

The following constituents were determined in the specimens: Moisture, total cellulose, a-cellulose, b-cellulose (obtained by deducting the a-cellulose from the total cellulose), xylan, constituents soluble in hot

water, in cold water, and insoluble in cold water, the nontannins, tannins, and ash.

In explanation of the above, it may be stated that the term cellulose, in a broad sense, is applied to the structural basis of a plant, that is, the cell wall. The substance of lignified cells, especially the woods, consists of a ligno-cellulose (a complex of carbohydrates), which by definite analytical methods may be resolved into two celluloses, a-cellulose, which is more resistant to chemical change and has been found to be an oxy-cellulose, and b-cellulose, which is more readily attacked. The xylan is a gummy substance present in all lignified tissues, and characterized by the fact that it yields a sugar when treated with acids. The nontannins are the constituents soluble in water which will not combine with hide substance, in other words, have no tanning properties. The tannins, on the other hand, combine with hide substance, and are those constituents of the bark which are commercially valuable and upon which its application in leather manufacture is based. The tannins are obtained by deducting the nontannins from the constituents soluble in cold water.

THE WESTERN HEMLOCK.

(*Tsuga heterophylla.*)

Three trees have been studied, their age being approximately 143, 142, and 50 years. The specimens were obtained at Priest Lake, Idaho, and the disks obtained from one of the trees were of sufficient size to permit analyses of the wood and bark from the north and south sides of the trunk. The results obtained on the individual disks show that there is no uniform variation in the composition of the wood from the ground to the base of the crown, with the exception of the xylan and ash, which increase somewhat irregularly, the highest amount of these constituents being usually found near the base of the crown. The disks were divided, whenever practicable, into three nearly uniform sections, representing the sap, middle, and heart woods, and the average results obtained on these specimens proved interesting, as they showed in general a decrease from the sap to the middle, and then an increase to the heart wood in the total cellulose and xylan present, while the water-soluble constituents exhibit a reverse relation, and the moisture and ash increase as we proceed from the outer edge of the disk to the heartwood. It was further found that these relations were in general true for both the north and south sides of the tree. The exposure (north or south) appears to have no influence on the composition of the wood.

THE WOOD.—A comparison of the wood of the three trees indicates that there is no definite relation between the average composition and the age of the tree. The youngest tree was found to contain a much lower amount of water-soluble substances, and thus of tannin, than the

older trees, but in the absence of corroborative work on other hemlock trees this difference can not be safely accepted as absolute. The wood of the hemlock is characterized by a high cellulose content, which is one factor of value in connection with its possible use as a source of wood pulp. The amount of water-soluble constituents is correspondingly small, this being notably true of the tannin, and of especial interest when we consider the amount of tannin present in the bark, which has been used as a tanning material for many years. The average composition of the wood of the Western Hemlock was found to be as follows:

Composition of the wood of the Western Hemlock.

		Per cent.
Moisture		6.13
Total cellulose		65.11
a-cellulose	42.44	
b-cellulose	22.67	
Xylan		7.54
Ash		.34
Constituents soluble in hot water		2.29
Constituents soluble in cold water	2.19	
Constituents insoluble in cold water	.10	
Nontannins	1.67	
Tannins	.52	
Undetermined (other carbohydrates, protein, etc.)		18.59
Total		100.00

The bark.—When the study of the bark of these hemlocks was taken up it was believed that unusually high results for tannin, the most valuable constituent, would be obtained, as a number of specimens previously received from Washington State had proved to be very rich in this respect. This hope was not realized, and the Western bark was, in general, found to have practically the same tanning value as the Eastern bark. It differs from the latter, however, in having a much lower amount of water-soluble constituents, this decrease being found chiefly in the nontannins. A comparison of the results fails to reveal any uniform variation in composition either with reference to the age of the tree or the distance from the ground at which the specimen was taken. The moisture content shows a well-defined tendency to decrease from the ground to the base of the crown, and the bark from the south side of the tree uniformly contains more moisture than that from the north side. The xylan increases, although irregularly, with the distance from the ground. In other respects, the barks from the north and south sides resemble each other very closely. Hemlock bark contains a considerable amount of ash, although not nearly so much as the oak barks, which will be discussed further on. The average composition of the bark was found to be as given on the next page.

Composition of the bark of the Western Hemlock.

		Per cent.
Moisture		9.76
Total cellulose		33.71
a-cellulose	26.30	
b-cellulose	7.41	
Xylan		5.35
Ash		1.75
Constituents soluble in hot water		13.48
Constituents soluble in cold water	12.50	
Constituents insoluble in cold water	.98	
Nontannins	4.00	
Tannins	8.50	
Undetermined (other carbohydrates, protein, etc.)		35.95
Total		100.00

STUDY OF OAKS.

The following oaks have been studied: Red Oak (*Quercus rubra*), Chestnut Oak (*Quercus prinus*), White Oak (*Quercus alba*), and Black Oak (*Quercus velutina*). The specimens were collected in Connecticut, the age of the trees varying from 16 to 57 years.

RED OAK.

(*Quercus rubra.*)

Five trees were studied, in three of which the size of the disks permitted a comparative investigation of the sap, middle, and heart woods.

THE WOOD.—The results primarily show that there is no definite variation in the composition of the wood proceeding from the lowest to the highest disk except in the ash, which exhibits a general tendency to increase, the maximum quantity being found near the base of the crown. The age of the tree also appears to have no specific influence. A comparison of the average data for the sap, middle, and heart woods, however, shows a well-defined increase from the sap to the heart on the part of the water-soluble constituents, among which the tannin is included, and also in the ash. The constituents which predominate in the cell wall remain remarkably constant. The average composition of the wood of the Red Oak is as follows:

Composition of the wood of the Red Oak.

		Per cent.
Moisture		10.77
Total cellulose		53.23
a-cellulose	31.79	
b-cellulose	21.44	
Xylan		20.33
Ash		.49
Constituents soluble in hot water		4.92
Constituents soluble in cold water	4.68	
Constituents insoluble in cold water	.24	
Nontannins	3.11	
Tannins	1.57	
Undetermined (other carbohydrates, protein, etc.)		10.26
Total		100.00

THE BARK.—The average results obtained by the analysis of a large number of specimens of the bark of the Red Oak show that it contains only about two-thirds as much cellulose as the wood and that a larger proportion of this is a-cellulose. Furthermore, the amount of xylan present is lower than in the wood, all of which is in accord with the cellular characteristics of the bark. The xylan increases from the ground to the base of the crown, while a reverse condition obtains for the ash. The ash content, furthermore, is very much higher than in the wood, and by comparison with hemlock bark, where a lower percentage of ash is associated with a higher tannin content, it would appear that the mineral matter present in the bark bears no close relation to the formation of tannin in the cell. The amount of total cellulose present in a bark is, however, much lower than in the wood, a larger proportion of this is a-cellulose, and the decrease is associated with a lower quantity of xylan, the latter being roughly an expression of the degree of lignification. These differences in the composition of wood and bark are in accord with the fact that the bark contains a large proportion of suberized (corky) tissue, which does not respond to the lignin tests, and suggest a relationship between the increase in ash and the lower percentage of cellulose present.

The bark contains a larger amount of water-soluble constituents than the wood; and a higher proportion of these consists of tannin. The average composition of the bark was found to be:

Composition of the bark of the Red Oak.

		Per cent.
Moisture		12.46
Total cellulose		35.11
a-cellulose	22.52	
b-cellulose	12.59	
Xylan		16.55
Ash		5.42
Constituents soluble in hot water		3.73
Constituents soluble in cold water	8.24	
Constituents insoluble in cold water	.48	
Nontannins	3.78	
Tannins	4.26	
Undetermined (other carbohydrates, protein, etc.)		21.73
Total		100.00

CHESTNUT OAK.

(*Quercus prinus.*)

THE WOOD.—The characteristics discussed with reference to the composition of the wood of the Red Oak apply equally to the wood of the Chestnut Oak, except that it was found to contain almost uniformly

a higher percentage of water-soluble substances, among which the tannin is included. The average composition of the wood follows:

Composition of the wood of the Chestnut Oak.

		Per cent.
Moisture		11.90
Total cellulose		54.07
a-cellulose	32.80	
b-cellulose	21.27	
Xylan		20.54
Ash		.54
Constituents soluble in hot water		5.27
Constituents soluble in cold water	5.04	
Constituents insoluble in cold water	.23	
Nontannins	2.44	
Tannins	2.60	
Undetermined (other carbohydrates, protein, etc.)		7.68
Total		100.00

THE BARK.—The bark of this oak is characterized by a comparatively low percentage of cellulose and xylan and a correspondingly higher amount of water-soluble constituents, one-half of which consists of tannin. There are no definite variations in the composition of the several specimens with the exception of the xylan and ash, the former increasing with the distance from the ground, while the latter appears to attain a maximum in the bark of the lowest disk, decreasing then to about the middle of the tree, when an increase is again noticed which continues to the base of the crown. The bark of the Chestnut Oak is a valuable tanning material, and is used in the fresh state and in the form of an extract. The average composition of the specimens examined was as follows:

Composition of the bark of the Chestnut Oak.

		Per cent.
Moisture		11.93
Total cellulose		30.37
a-cellulose	17.86	
b-cellulose	12.51	
Xylan		13.43
Ash		4.32
Constituents soluble in hot water	11.08	
Constituents soluble in cold water	10.52	
Constituents insoluble in cold water	.56	
Nontannins	4.53	
Tannins	5.99	
Undetermined (other carbohydrates, protein, etc.)		28.87
		100.00

WHITE OAK.

(*Quercus alba.*)

THE WOOD.—The wood of the White Oak presents no striking differences in its composition when compared with that of the oaks previously discussed, except that it contains a much smaller quantity of water-soluble constituents and thus much less tannin. The average composition of the wood is shown in the following:

Composition of the wood of the White Oak.

		Per cent.
Moisture		11.63
Total cellulose		56.56
a-cellulose	34.79	
b-cellulose	21.77	
Xylan		18.83
Ash		.54
Constituents soluble in hot water		3.10
Constituents soluble in cold water	2.90	
Constituents insoluble in cold water	.20	
Nontannins	1.58	
Tannins	1.32	
Undetermined (other carbohydrates, protein, etc.)		9.24
		100.00

THE BARK.—The bark differs materially from that of the Red and Chestnut oaks in that it contains the least amount of cellulose, almost all of which is a-cellulose. The ash content of this bark is higher than in any of the other oaks, and it also contains a considerable amount of tannin. It does not appear to possess good tanning qualities, however, and is not much employed for this purpose. The variations in the percentage of xylan and ash present in the bark, proceeding from the ground to the base of the crown, are in general the same as in the Red Oak. The average composition of the bark is as follows:

Composition of the bark of the White Oak.

		Per cent.
Moisture		12.65
Total cellulose		29.22
a-cellulose	23.87	
b-cellulose	5.35	
Xylan		12.37
Ash		8.27
Constituents soluble in hot water		10.53
Constituents soluble in cold water	9.87	
Constituents insoluble in cold water	.66	
Nontannins	3.56	
Tannins	6.31	
Undetermined (other carbohydrates, protein, etc.)		26.96
Total		100.00

BLACK OAK.

(*Quercus velutina.*)

Only one tree of this species was studied, the investigation including the sap, middle, and heart woods of four disks.

THE WOOD.—As in the previous cases, the variations in the composition of the wood appear to bear no definite relation to the distance from the ground at which the individual disks were cut, the chief exception being the ash, which attains a maximum near the base of the crown. The results obtained on the sap, middle, and heart woods indicate that in general the water-soluble constituents reach their maximum in the middle wood, a decrease being noted in the heart wood. The average composition of the wood was found to be:

Composition of the wood of the Black Oak.

		Per cent.
Moisture		13.74
Total cellulose		51.09
a-cellulose	30.84	
b-cellulose	20.25	
Xylan		19.51
Ash		.46
Constituents soluble in hot water		5.67
Constituents soluble in cold water	5.30	
Constituents insoluble in cold water	.37	
Nontannins	3.46	
Tannins	1.84	
Undetermined (other carbohydrates, protein, etc.)		9.53
Total		100.00

THE BARK.—The bark of the Black Oak is very rich in tannin and is used in the manufacture of leather. The xylan and ash exhibit the same characteristic variations already noted for these constituents in the other oaks. The average composition of the bark was found to be:

Composition of the bark of the Black Oak.

		Per cent.
Moisture		11.40
Total cellulose		31.98
a-cellulose	16.32	
b-cellulose	15.66	
Xylan		15.70
Ash		5.06
Constituents soluble in hot water	16.38	
Constituents soluble in cold water	12.95	
Constituents insoluble in cold water	3.43	
Nontannins	5.21	
Tannins	7.74	
Undetermined (other carbohydrates, protein, etc.)		19.48
Total		100.00

STUDY OF THE ANATOMY AND HISTO-CHEMISTRY OF OAKS.

In connection with the above purely chemical studies an investigation has been conducted by Mr. B. J. Howard, which embraced the anatomy and histo-chemistry of the White, Black, and Red oaks, the development of and changes within the cell being carefully observed. It is a well-known fact that during the active growing period of the year plants store away in convenient form, in certain portions of their organism, materials which are to be used later when the constructive power of the plant is not so vigorous. Starch is one of the most common forms in which such materials are stored. When a cross section of an oak branch is dipped into an aqueous solution of iodin for a few seconds it will generally be found that certain portions have turned a deep blue or black, the most prominent being the pith. Thin sections of a twig, when stained with iodin and examined with the microscope, will show that the pith cells are essentially hexagonal cylinders having comparatively thin walls, with large cavities. In the fall and winter condition these cells are heavily loaded with starch grains which are very small, being only about 6 microns ($\frac{1}{4000}$ inch) in diameter, and having no prominent markings. Their deposition begins early in the season. About the first of July the pith is for a short time almost devoid of starch, but as soon as the most active work of building up new tissues is accomplished the supply of carbohydrates exceeds the immediate need, and the excess is stored away for future demands. By the end of July a considerable quantity has been thus deposited. The medullary rays and the wood parenchyma cells also serve as storehouses for starch, and in some parenchyma cells of the bark small grains are found at certain times of the year. It would appear that the ability to store starch in the pith, medullary rays, and wood parenchyma exists only as long as the cells contain living protoplasm.

The rôle of the tannin is still an open question, certain physiologists claiming that it plays an active part in the plant economy, while some regard it as merely a by-product of metabolism. Others take an intermediate position, believing that in some plants it is an active constituent, while in others it appears merely as a by-product or as a means of protection. In the oaks the tannin occurs chiefly in the parenchymatous tissue of the bark, and the zone of greatest abundance lies between the hard bast and cambium (formatic) layer. Although the tannin has been determined in oaks for different months, it is not yet possible to correlate the yield with any period, either of rest or special activity on the part of the tree. It was found, however, that at the end of spring, when the supply of starch was nearly exhausted, there seemed to be a slight increase in the amount of tannin present in the pith.

Calcium oxalate crystals are present in the rhomboidal and the rhaphidian (needle-like) forms, but the two forms never occur

together in the same cell. The former are found in the parenchyma cells of the wood and in those adjacent to the hard bast. The latter occur most abundantly in the primary cortex and to some extent in the soft bast. Although the crystals are abundant in the cells which contain starch, yet they never appear to be formed simultaneously in the same cell.

The development and chemical changes which occur in the tissue of the oaks during growth form another part of the study. In the spring, as soon as the leaves have attained one-half or two-thirds of their normal size, small buds appear in the leaf axils. Even in the last part of May or in early June these were found to contain in a quite well-formed condition the primary tissues of the next year's twigs. The spiral vessels which pass out to form the primary vascular system of the leaves are the first to be formed in the twig, and the vessels, formed subsequently in the woody portion, are of the reticulated type.

In the formation of new cells the middle lamella (layer) is first produced, the later thickening of the walls resulting from depositions on the inside. These depositions form concentric layers, as is easily shown by treating the section with iodin solution followed by 55 per cent sulphuric acid. The substance of the cell wall at first consists of a cellulose, which is stained blue when treated with iodin followed by sulphuric acid. It is also stained readily by Kleinenberg's hæmatoxylin solution. After the growth of the cell wall has been nearly or fully accomplished, a secondary change occurs, causing chemical and physical modifications in its nature. This process, called lignification, first occurs in the spiral vessels and then spreads to neighboring cells. The middle lamella first lignifies and later the inner lamella. Lignification renders the cell wall much harder, and it will subsequently respond only feebly to tests for cellulose. Other staining materials also demonstrate the change produced in the tissue by lignification. It can no longer be stained with hæmatoxylin, while safranin, which is a very poor cellulose stain, is readily taken. A solution of phloroglucin in hydrochloric acid gives a very characteristic reaction with lignified tissue in that it stains such tissues a deep red. This reaction was formerly supposed to be caused by the presence of vanillin, but has been shown by Czapek to be due to another constituent of aldehyde nature, and called by him "hadromin."

A difference has also been found to exist between the middle and inner lamellæ. The inner lamella will swell up and dissolve in 55 per cent sulphuric acid, while the middle lamella yields only on prolonged action. They also differ in their behavior toward Schultze's solution (potassium chlorate dissolved in strong nitric acid) in that the middle lamella is readily dissolved, while the inner lamella is attacked only slowly. It is so far impossible to decide, with our present knowledge

of the chemistry of the cell wall as a basis, whether these constituents are chemically combined into molecules of high complexity or are present only in the form of an intimate mechanical mixture. The latter view is more commonly accepted.

The investigation has shown that the identification of the species with the anatomical structure as the sole basis is practically impossible. Extensive measurements revealed individual differences in the same species which were often greater than the average of different species.

Turpentine Adulteration.

From time to time complaints have come to the notice of the laboratory touching the unsatisfactory behavior of turpentine oils purchased in the open market. A number of samples of oil from different sources were therefore collected for examination and analyzed by Mr. Andrew Stewart, and a number of these were found to contain adulterants.

In taking up this work it is to be clearly understood that it has never been the intention to fix responsibility for what adulteration might be disclosed, as it was recognized that any such attempt would probably fail, owing to the way in which the ultimate collection of turpentine is made in the South and considering the number of hands through which the product passes before it is finally used. The sole aim has been to apprise turpentine purchasers at large of the fraud being practiced upon them.

It is no easy matter to detect adulteration in turpentine oil, first because the substances usually employed for that purpose are of much the same nature as the turpentine, and second, because the latter itself is within limits variable and of great complexity, which makes the determination of constants both difficult and unsatisfactory.

While the principal constituent of turpentine is pinene ($C_{10}H_{16}$), oil taken from different varieties of pine will vary. Therefore, a lot of oil coming into the market may be of one sort exclusively, or, what is far more likely, it may represent a mixture, as it is the practice in the turpentine region to combine the products of the smaller stills before shipment.

American turpentine is obtained principally from *Pinus palustris* and *Pinus heterophylla*, indigenous to the Southern States. It is generally obtained by distilling with steam the flowing sap of the tree ("virgin dip"), collected from notches ("boxes") cut in the trunk, or the partially dry sap ("scrape") which forms on the wounded surface.

The turpentine oil distills over with the steam, leaving behind a molten residue which, on cooling, hardens into the well-known rosin. During the distillation the oil and steam are liable to carry along a minute quantity of rosin. The residual rosin, when further distilled, yields rosin oil, a thick liquid of high specific gravity, refractive

index, and boiling point, and very strong violet fluorescence. Turpentine oil is a limpid liquid more or less tinted with yellow, the best quality being well-nigh colorless and giving forth a pleasant aromatic pine odor. It should be clear, and some specimens show a violet fluorescence. The boiling point lies in the neighborhood of 156° C. (312.8° F.), and during the distillation of the first tenth fraction the mercury rises to about 158° to 160° C. (316.4° to 320° F.), where it lingers until something like 70 per cent has passed over, when it gradually mounts higher, the boiling point of the last tenth being between 160° and 170° C. (320° and 338° F.). The specific gravity of the whole sample should average in the neighborhood of 0.8672 (the mean of 12 specimens of genuine oil), and the refractive index, which runs parallel, should be about 1.4680. The specific gravity of the first tenth fraction should be lighter than that of the whole sample; that of the last tenth much heavier.

The adulterant usually encountered in sophisticated turpentine is petroleum in one or more of its fractions. When the lower boiling fractions, such as gasoline, are used the turpentine is rendered specifically lighter, and to counteract this, rosin oil is often added. It has been the experience of this laboratory that frequently a higher boiling fraction is resorted to. A turpentine so doctored will probably have a lower specific gravity, though it will boil at an approximately lower temperature. The specific gravity of the first tenth fraction will generally be greater than that of the whole sample; that of the residual lighter. It will usually be impossible to distill to the last tenth fraction without the distillate becoming cloudy and the residue browning. The mercury rises more uniformly and gradually throughout, and it mounts to a much higher point as the end of the distillation approaches, going sometimes over 200° C. (392° F.).

The literature on the subject of turpentine adulteration is not voluminous, nor are the tests recommended in many instances practical or satisfactory. The tests that have been found to render the greatest service in this laboratory, besides the determination of the specific gravity, refractive index and flash point, and the fractional distillation, are based upon the solubility of the oil in different media, such as anilin, acetic acid, the determination of the residue left on evaporation, the bromin absorption capacity, etc.

Turpentine is used chiefly as a diluent and solvent in the preparation of paints and varnishes, and adulteration primarily injures the specific properties upon which its value and application in these extensive industries depend. It furthermore works harm not only to the manufacturer of the paint or varnish, but also to the consumer of the finished product, both as to financial loss and personal inconvenience.

BACTERIA AND THE NITROGEN PROBLEM.

By George T. Moore,

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INTRODUCTION.

There is probably no fact in plant physiology which has been more firmly established than that all plants must have nitrogen in order to thrive, and that under normal conditions this nitrogen must be obtained through the roots in some highly organized form. It is not necessary to discuss this point, for practical experience demonstrates its truth every time a soil is exhausted by any crop, and the farmer testifies to his belief in this fact when he tries to reestablish the fertility of his ground by adding some fertilizer rich in nitrogenous matter. While there are certain other substances, such as phosphoric acid, potash, iron, etc., which plants must have and can only obtain through the soil, the demand for nitrogen is so much greater and in one sense so much more important, that the question of the available nitrogen supply in the world has come to be looked upon as lying at the very foundation of agriculture and demanding the most careful consideration. Since the conditions of life in the civilized quarters of the globe are such as to cause a constant loss of nitrogen, there have been some who have predicted what has been termed a "nitrogen famine," which is to occur within the next forty or fifty years, and the possibility of such a catastrophe has been very graphically portrayed. On the other hand, there are investigators who feel that the possibility of such a condition has been much exaggerated and that the amount of nitrogen in the soil can never be exhausted to such an extent as to affect the crop-producing power of the earth. In order that we may be able to form a more definite opinion upon the subject, it may be well to look at some of the ways in which nitrogen is lost, and then see how it may be reclaimed.

HOW NITROGEN IS LOST.

In the first place, the conditions of life on the ordinary farm are such as to cause the constant loss of this valuable element through the removal of the crops taken from the soil. If every crop that grew on the land could be returned to it, nature has made provision for getting

it back in suitable form for plant food. In the case of nitrogen, neither plants nor animals are able to produce this substance directly in an available form. It is necessary that certain bacteria take hold of plant and animal products, and by means of peculiar changes produce nitrates from their fats, sugars, starches, etc. Without these bacteria everything would have come to a standstill long ago, for unless decay takes place and the decomposed elements are rearranged into definite nitrogenous salts no plant is able to use them. Thus, it will be seen that certain bacteria in the soil play as important a part in the food supply of the earth as do the animals and larger plants upon which we think we are so dependent.

It is hardly necessary to refer to the vast waste of nitrogenous material that is involved in modern sewage methods. Millions of dollars' worth of nitrogen which would naturally return to the soil under the action of nitrifying bacteria is every year carried off in various waterways and ultimately reaches the ocean, where, of course, it is of no benefit to man. More than fifty years ago Liebig said on this subject:

> Nothing will more certainly consummate the ruin of England than the scarcity of fertilizers. It means the scarcity of food. It is impossible that such a sinful violation of the divine laws of nature should forever remain unpunished, and the time will probably come for England, sooner than for any other country, when with all of her wealth in gold, iron, and coal she will be unable to buy the one-thousandth part of the food which she has during hundreds of years thrown recklessly away.

A third great source of nitrogen loss is through the action of a group of bacteria which have the power of breaking down nitrates, depriving them of oxygen, and reducing them to ammonia or nitrogen gas, when they are, of course, unavailable for plant food. This process of denitrification, while very useful in the septic tank, which is the most sanitary method of sewage disposal, is the source of considerable loss to the farmer, and manures may often be rendered practically worthless by the action of these bacteria.

Other means by which nitrogen is lost so far as plant foods are concerned, are the washing out of nitrogen salts from the soil and the burning of explosives which are largely composed of some nitric salt that would be directly valuable to the vegetable kingdom. The action of nitrate of soda, or saltpeter, has been studied experimentally, and it is known that up to a certain maximum about 23 pounds of nitrate of soda will yield an increase of 1 bushel of wheat per acre. Thus, when hundreds of thousands of tons of explosives are used in waging war, every battle liberating nitrogen which, if applied to the soil, would increase the yield of wheat by thousands of bushels, the actual cost of war should be estimated at considerably more than is usually calculated; and if there is soon to be a nitrogen famine, war becomes more serious than ever before.

With all of these destructive forces at work and nitrogen being liberated on every hand, it is no wonder that thinking men have become alarmed at the prospect, and have endeavored in every way possible to discover some means of increasing the world's supply of this most necessary element.

HOW NITROGEN IS GAINED.

The most valuable compound containing sufficient fixed nitrogen to be used in any quantity as a nitrogenous fertilizer is the nitrate of soda, already referred to as the basis of so many explosives. This salt occurs naturally in certain regions of Chile and Peru, where for countless centuries the continuous fixation of atmospheric nitrogen has been carried on by bacteria. Unfortunately, however, like any other mineral supply in the earth, the quantity is limited, and although it is difficult to get accurate estimates of the amount of nitrate remaining in the beds, authorities seem to agree that at the present rate of export the raw material will all be exhausted within from forty to fifty years. To show how much more rapidly this supply is being exhausted than was thought possible forty years ago, it is only necessary to state that in 1860 all estimates showed that the amount of nitrate of soda then known would last for nearly fifteen hundred years. The demand has rapidly increased, however, and although the output is controlled, there is annually consumed in the world's markets nearly 1½ million tons of nitrate of soda, representing a value of about $100,000,000. Of this amount, the United States requires about 15 per cent, and it is by far the most expensive fertilizer that is in use by the farmer.

In addition to the nitrate of soda beds there have also been large deposits of guano, which have served as one of the principal sources of nitrogen. The greater part of the guano beds are now completely exhausted, however, and although new deposits are occasionally discovered, they are of such limited area, or of such a low percentage of nitrogen, as to have practically no effect upon the available nitrate supply.

There are certain other chemical salts which furnish a limited amount of nitrogen, such as the product which remains from the distillation of coal in the process of gas making, but all of them are obtained in such comparatively small quantities that they are not worth taking into consideration when one realizes the enormous amount of nitrogenous fertilizer necessary to replace the combined nitrogen which is annually removed from the soil in one way or another.

Ever since the importance of increasing the combined nitrogen supply has been realized, men of science have naturally turned to the atmosphere as being the most promising field for experiment and the one most likely to eventually solve the whole problem. When it is

remembered that nearly eight-tenths of the air about us is nitrogen, and that plants are able to obtain their entire source of carbon from a gas which is present in the comparatively small proportion of one-tenth of 1 per cent, it seems almost incredible that there should be any more difficulty about a plant's nitrogenous food than about its supply of carbon dioxid. Since it seemed so well settled, however, that plants could not use nitrogen as a gas, the chemists and physicists have made every effort to devise some mechanical means of making this element available in a combined form. It has been known that discharges of lightning passing through the air are able to fix free nitrogen, and, beginning with this as a basis, some very satisfactory results have been obtained by the use of electricity. With a power sufficiently cheap and with perfect machinery, there seems good reason to believe that in the near future it will be possible to place upon the market a manufactured nitrate of soda or nitrate of potash that will be superior in quality to the deposits found in South America, and that will also be reasonable enough in price to compete with the natural product.

NITROGEN-FIXING BACTERIA.

Fortunately, there are still other means by which nitrogen gas may be made available for plant food, and that, too, without requiring the introduction of a commercial product, which must always be rather expensive, whatever degree of perfection may be reached in the mechanical operation of the process. Ever since the earliest days of agricultural science it has been noticed that certain land, if allowed to stand fallow for a considerable length of time, would gain in nitrates without any visible addition having been made. It is now known that one of the principal means of this increase in nitrogen content is due to a few forms of soil bacteria which have the power of fixing the free nitrogen from the air and rendering it available for plant food. These organisms have been isolated and cultivated artificially, and great hopes were held at one time that it would be possible to inoculate land with these cultures and thus bring about a large increase in the nitrogenous salts without the aid of any manure or mineral fertilizer. Under certain conditions these bacteria seemed able to do a large amount of work, and there are experiments on record where the crops raised from plots inoculated with nitrogen-fixing organisms were much greater than crops from uninoculated land. Unfortunately, these results were not always constant, and such a large percentage of failures had to be reported that from a practical standpoint the use of such cultures is now considered worthless. A matter of such vast importance to agriculture, however, should not be neglected simply because of first failures. It is quite possible that as we become better acquainted with the habits of these

TUBERCLES OF VELVET BEAN PRODUCED BY INOCULATION.

[Natural size.]

FIG. 1—CROSS SECTION OF TUBERCLE OF LUPINUS ANGUSTIFOLIUS, CONTAINING BACTERIA. X 46.

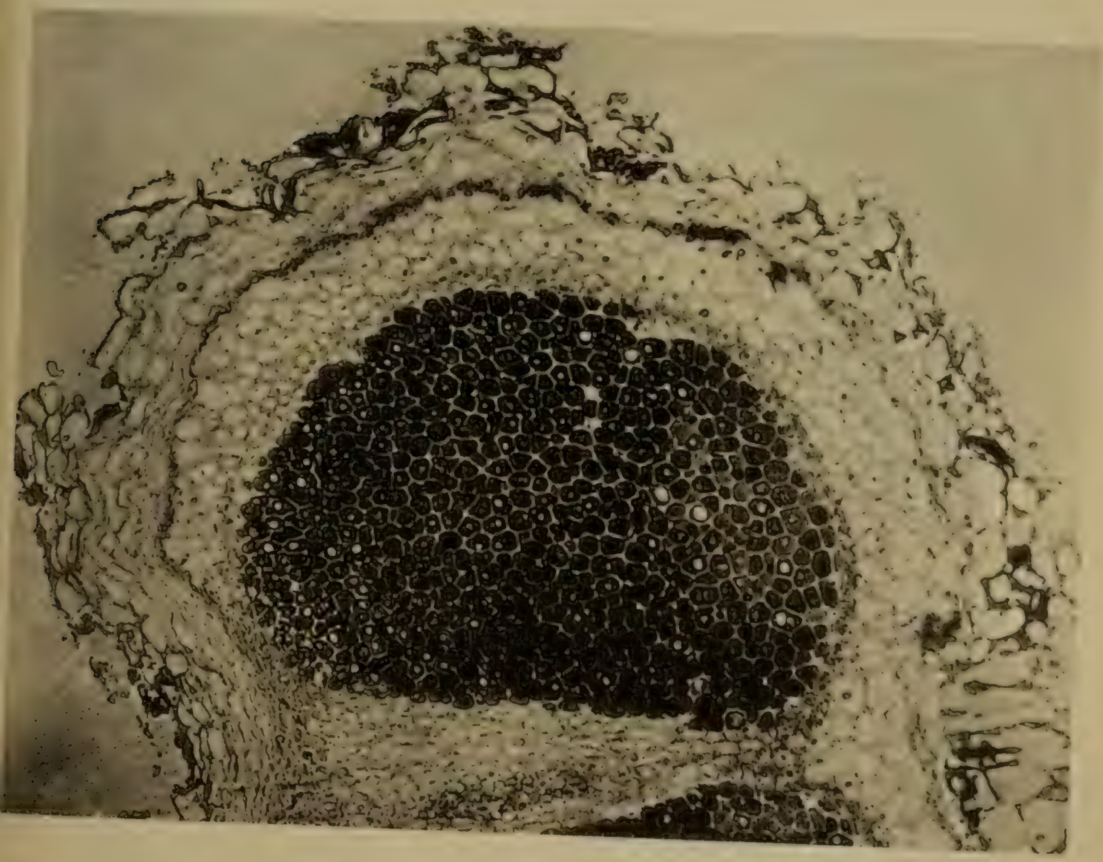

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FIG. 2.—CROSS SECTION OF ONE LOBE OF LUPINE TUBERCLE, CONTAINING BACTERIA. X CIRCA 80.

bacteria and learn the conditions which are most favorable to fixing nitrogen and the causes which prevent this operation from going on at all times, we shall be able to discover some means of using these nitrogen gatherers in practical farming.

ROOT TUBERCLE BACTERIA.

In the meantime there is still one other means at hand which can be used and has been used for countless centuries as a most efficient method of conserving the world's nitrogen supply. Ever since the time of Pliny and other early writers upon agricultural topics, it has been known that certain leguminous crops, such as clover, beans, peas, etc., did not require the same amount of fertilizer as other plants, and indeed it seemed as though they actually benefited the soil instead of being a detriment. Various theories have been advanced to account for this effect, perhaps the most widespread opinion being that members of this family, owing to the unusual length and strength of their root system, were able to draw upon a store of food that was not available to wheat and corn and other crops not belonging to the pod-bearing group. It is only within a comparatively recent time that the real cause of the beneficial effect of these legumes has been fully understood, and it seems that here again the bacteria are responsible for the nitrogen-gathering power; for it is because these plants are able to fix and use the free nitrogen of the air that they are of such benefit in rotation and in reviving poor and exhausted land. The immense yields of wheat following alfalfa or clover are easily understood when it is realized that there has actually been added to the soil a certain definite amount of nitrogen in such form that the wheat can be benefited by it. Such efficient users of the atmospheric nitrogen are clover and peas and similar crops that they can actually live and thrive in a soil that has not the first trace of combined nitrogen within it. If quartz sand be ignited to red heat, thus burning out all the nitrates, and then be planted with peas or beans, it is possible to bring these plants to full maturity without in any way allowing a particle of fixed nitrogen to find its way into the soil. On the other hand, wheat or potatoes, or crops not legumes, will die as soon as the small amount of nitrogen available from the seed is exhausted. What is the reason for this? It can not be merely a difference in the length or extent of the root system, because plants flourish where it is certain there are no available nitrates whatever. For a long time the presence of certain peculiar nodules or tubercles upon the legumes has been noted and speculated upon. These formations are always present upon the roots of leguminous plants grown under proper conditions, and may vary in size from that of the smallest pin head, in some clovers, to a cluster as large as a potato, as shown in Pl. XXXVII, a natural-sized view of the inoculated roots of

a velvet bean plant. They have been thought to be due to the bites of worms and insects, or to be caused by conditions of the soil and various abnormal climatic effects, and only within very recent years has it been learned that these formations are due to the presence of innumerable bacteria, and that unless these tubercle-producing bacteria exist the plant is no more able to use the nitrogen from the air than wheat or any of the other crops which do not have such nodules on their roots.

MICROSCOPIC APPEARANCE OF TUBERCLES.

If a thin cross section of one of these tubercles be examined under the microscope it will be seen that the cells are very much larger than in a normal root, and that almost the entire contents have been replaced by masses of minute bacteria (Pl. XXXVIII). These bacteria gain an entrance into the plant through the root hairs, and may assume shapes very different from the ordinary rods and spheres that are usually found in this group. The appearance of branching forms similar to those shown in Pl. XXXIX, fig. 1, has led some observers to consider that these tubercle formers were not true bacteria, but belonged to some group intermediate between the bacteria and fungi. This is not probable, however, for there is abundant evidence to prove their relationship to the true bacteria, and while the peculiar shapes are somewhat characteristic of the group, they are not exclusively of this form, many tubercles having nothing but the short rods, as shown in Pl. XXXIX, fig. 2.

Just where the nitrogen is fixed and how it is used by the plant have been debated questions. Some have supposed that the presence of the bacteria in the roots simply acted as a stimulus, and that the leaves of the plant were thus able to take in nitrogen as a gas and to elaborate nitrates from it in some such way as carbon is formed from carbon dioxid. It seems much more probable, however, that the bacteria themselves fix the nitrogen in the roots of the plant and that it is then used as nitrates would be used from the soil. It is certain that these tubercle organisms can fix free nitrogen in cultures, and there is no reason to suppose that this power is lost when within the roots of a legume. Furthermore, it seems as though the plant actually uses the contents of these tubercles, for at the end of the season the tubercles are found to be much softer and shrunken, and are practically emptied of their mass of bacteria.

EFFECT OF TUBERCLES.

The effect of the presence of tubercles upon vetch may be seen from Pl. XL, where two plants, one with and one without tubercles, are shown. This is a very poor example, however, of the benefit of these tubercles to a whole crop. While it is difficult to show in a photograph a field that will bring out the advantage of the presence of the nitrogen

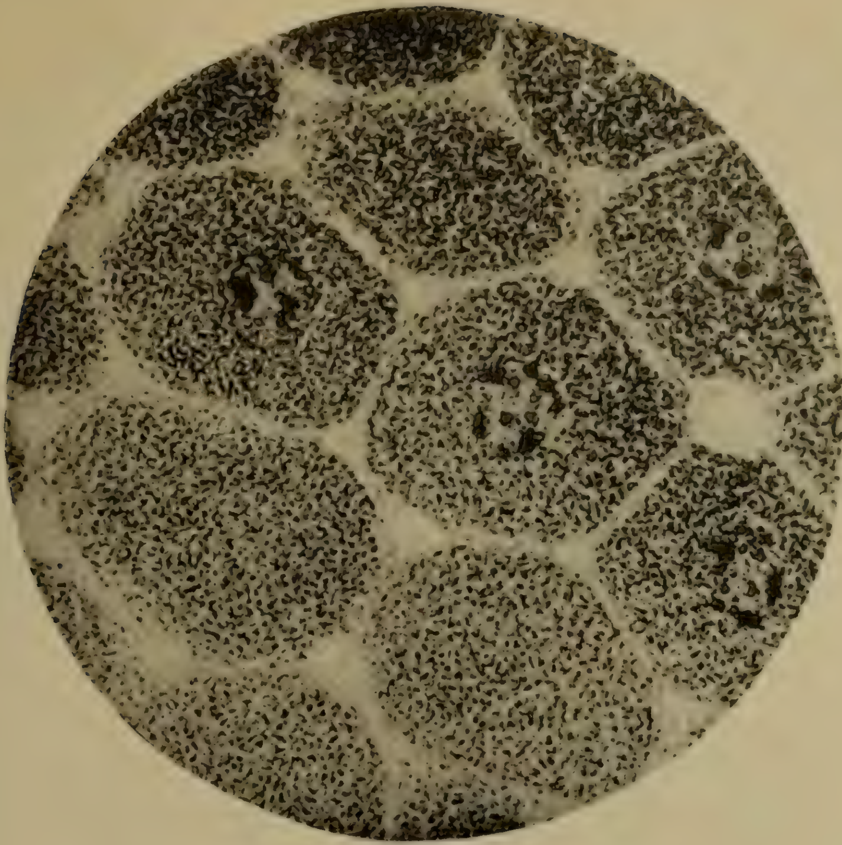
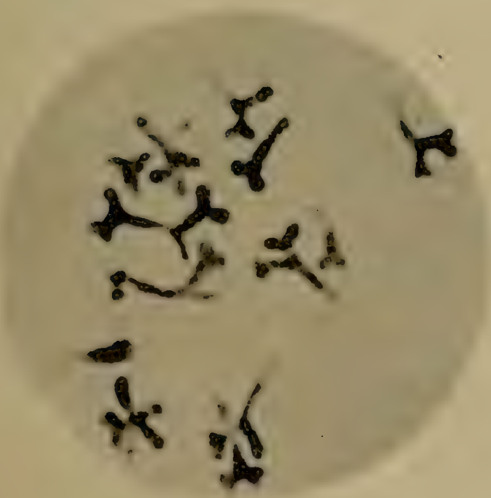


FIG. 1.—A FEW CELLS FROM PLATE XXXVIII HIGHLY MAGNIFIED TO SHOW THE BACTERIA; FOUR CELLS WITH NUCLEI. X 1000



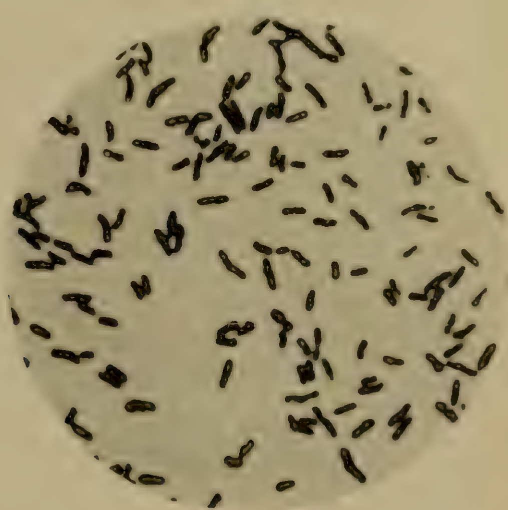


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FIG. 2.—BRANCHING FORMS FROM CLOVER TUBERCLE. X 2000

FIG. 3.—ROD FORMS FROM FENUGREC TUBERCLE. X 2000

COMPARISON OF VETCH PLANTS GROWN UPON INOCULATED AND UNINOCULATED SOIL.

[Reduced about one-third.]

fixing bacteria, perhaps Pl. XLI will illustrate this difference in a general way. It is a well-established fact, and has been shown by a number of independent investigators in various parts of the country, that the leguminous crop which bears tubercles will exceed a similar crop without tubercles by from 100 to 1,000 per cent; that is, a field of clover grown on such poor soil that it would only yield 200 pounds to the acre would be so invigorated by the presence of tubercle-forming bacteria that on exactly similar soil it would produce from 400 to 2,000 pounds to the acre, and this without any cost whatever for fertilizers and with very little more labor. In addition to the increase of the actual weight of the crop, tubercles also cause the plants to flower and fruit earlier, and the number of seed produced is very much greater.

Thus it will be seen that it is worse than useless to attempt to grow any leguminous crop without being certain of the presence of the bacteria which enable the plant to fix free nitrogen. It would be much better to fertilize heavily and attempt to raise some more profitable crop than to introduce clover or beans or some other legume for the purpose of enriching the soil. It can not be too strongly emphasized that unless the tubercles are present the leguminous crop is of absolutely no more benefit to a soil than wheat or potatoes.

While these organisms are pretty generally distributed throughout the earth, and it is quite possible in many parts of the country to grow almost any leguminous crop and secure these tubercles, it is also true that certain regions are practically devoid of the right kind of bacteria, and that unless some artificial means of introducing the germs be resorted to the crop will be a failure.

ARTIFICIAL INOCULATION OF THE SOIL.

In the past there have been two methods used in attempting to bring about artificial inoculation. Naturally where a certain leguminous crop has been grown successfully for a number of years the soil will become filled with tubercle organisms, and by transporting this earth to new fields the organisms will thus become available for forming the nodules in localities where they previously had not existed. This was the means by which the soy-bean organisms were brought from Japan, and there are very few places in this country where soy is now grown that did not receive their inoculation, indirectly at least, from the Japanese soil.

There are two serious objections to soil inoculations, however. One is the expense, for it requires anywhere from 500 to 1,500 pounds of earth per acre to produce a satisfactory growth of tubercles, and if this has to be transported for a large farm, the cost is almost prohibitive. There is still another and more serious objection, however, and that is the danger of transmitting plant diseases by this method. Several of the more serious diseases which attack crops are readily

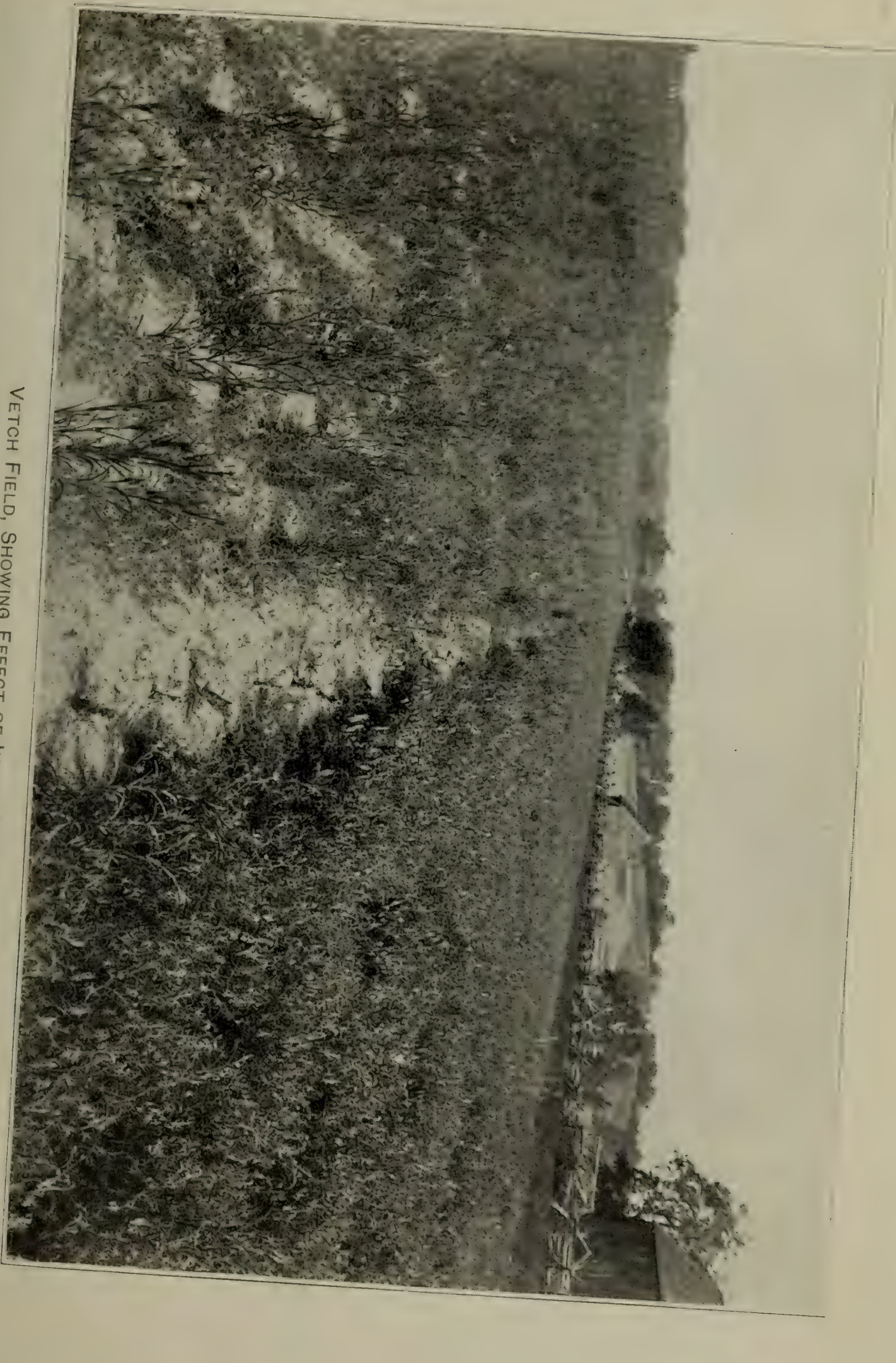
conveyed in the soil, and there are numerous cases on record where diseases of leguminous and other crops have been introduced into regions previously entirely free from them through an effort to bring about a soil inoculation of the tubercle-forming organism. Consequently, if any safer and cheaper method could be devised for making these germs available, it would be most desirable.

A few years ago certain German investigators put upon the market a product known as nitragin, which purported to be a pure culture of the root-tubercle organism. These cultures were only adapted to specific crops, for it has been held that each kind of leguminous plant had a special germ better adapted to produce tubercles upon it than any other form, and for this reason it was necessary to use one organism for clover, another for peas, and so on. This preparation, nitragin, has been used with varying success abroad. Some experiments seemed to show that it was of the greatest value, while others were complete failures in demonstrating its worth. The failures so far outnumbered the successes, however, that its manufacture has been abandoned, and it can no longer be obtained. A few attempts have been made to use these cultures in this country, and while some very satisfactory results were obtained, the number of failures was even greater than abroad, the varying conditions involved in transportation and the length of time which elapsed before the germs could be used being fatal to about 80 per cent of the material imported.

IMPROVED METHOD OF INOCULATION.

A little more than a year ago the investigation of these nitrogen-fixing bacteria was begun in the laboratory of plant physiology of the Bureau of Plant Industry, with the hope of discovering some method of artificially inoculating soils which were devoid of the proper organisms, and of insuring their producing the desired result. It was soon found that the method in use by the German investigators was not adapted to the life of the organism; that is to say, the use of rich nitrogenous food material, such as decoctions of the host plant, were not calculated to produce an organism which would fix free nitrogen from the air. It was found that while the bacteria grew luxuriantly upon such media, they became less and less active, until eventually they lost completely this nitrogen-fixing power. It seemed as though the large amount of nitrates in the media upon which they were grown made it no longer necessary to draw nitrogen from the air, and consequently they deteriorated until they became of no more value than the common soil forms. It has been found, however, that by gradually reducing the amount of nitrogen in the culture medium it is possible to greatly increase the nitrogen-fixing power of these germs, and that by proper manipulation their activity may be increased from five to ten times that which usually occurs in nature. Practical

PLATE XLI.



VETCH FIELD, SHOWING EFFECT OF INOCULATION.

[Uninoculated plat at left; inoculated plat at right.]

FIG. 1.—ROOTS OF SOY BEAN GROWN IN SOIL INOCULATED WITH ORGANISMS FROM RICH NITROGENOUS MEDIA.

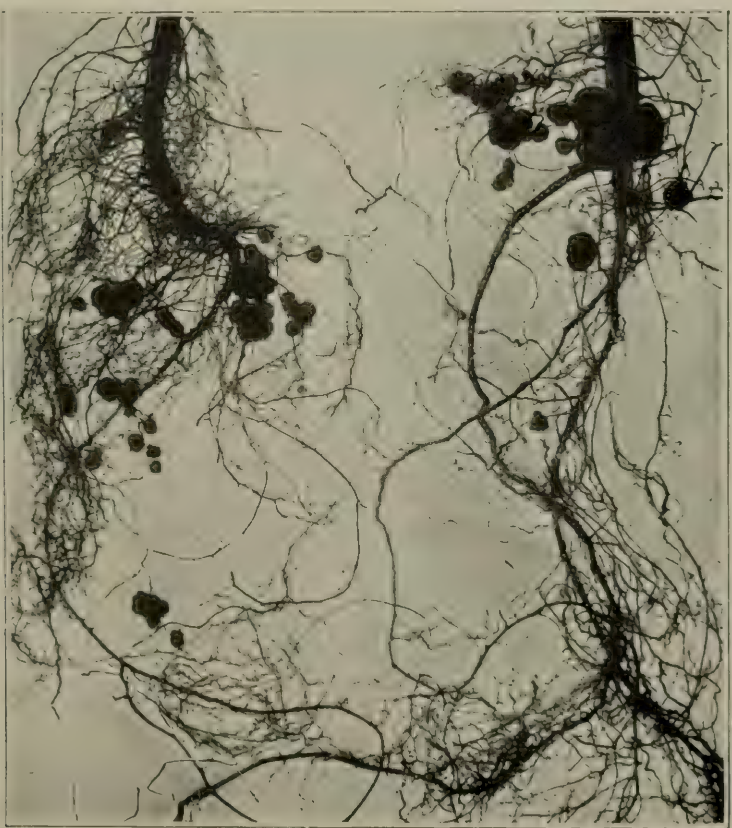


FIG. 2.—ROOTS OF SOY BEAN GROWN IN SOIL INOCULATED WITH ORGANISMS FROM NITROGEN-FREE MEDIA.

[Both figures reduced one-third.]

field experiments have shown that of two cultures, one grown on nitrogen-free media and the other on a medium rich in nitrates, the first will produce abundant tubercles, while the latter will be absolutely worthless and fail to produce a single nodule. (See Pl. XLII.)

DISTRIBUTION AND METHODS OF USE OF CULTURES.

Having secured an organism which was able to fix such a large amount of nitrogen, it was necessary to devise some means of preventing this property from being lost, as well as to enable the cultures to be distributed in sufficient quantity to be of some practical use. It is now known that the bacteria, when grown upon nitrogen-free media, will retain their high activity if they are carefully dried out and then revived in a liquid medium at the end of varying lengths of time. By using some absorbent which will soak up millions of the tubercle-forming organisms and then by allowing these cultures to become dry the bacteria can be sent to any part of the United States, or the world for that matter, and yet arrive in perfect condition. Of course, it is necessary to revive the dry germs by immersion in water, and with the addition of certain nutrient salts the original number of bacteria is greatly increased if allowed to stand for a short time. Frequently twenty-four hours are sufficient to cause the water in a pail to turn milky white with the number of organisms formed in that time. Thus, by sending out a dry culture, similar to a yeast cake and no larger in size, the original number of nitrogen-fixing bacteria may be multiplied sufficiently to inoculate at least an acre of land. The amount of material thus obtained is limited only by the quantity of the nutrient water solution used in increasing the germs. It is evident, therefore, that the cost of inoculating land is very small. The principal cost is in obtaining the organisms, but the methods perfected by the Department of Agriculture now make it possible to produce these at a comparatively small cost. Special facilities for increasing the culture on a large scale are being provided.

The way in which this liquid culture may be introduced into the soil varies somewhat with the character of the seed to be used and the area of the field to be treated. With large seed it is often more convenient to simply soak them in the fluid and then after they are sufficiently dry to sow them in the ordinary way. In other cases it is frequently more feasible to introduce the liquid culture directly into the soil. This may be done by spraying, or perhaps a simpler method is to mix the culture thoroughly with a wagonload of earth and then to distribute and harrow this in just as a fertilizer would be handled. Inoculations of this character have been tried on a large scale in practical field experiments, and the results have been so satisfactory that the Department of Agriculture will probably soon be able to begin the introduction of cultures into such localities as are now deficient in

tubercle-forming germs. It should be borne in mind that such inoculations are usually not necessary in soil that is already producing tubercles. While the introduction of fresh organisms will generally considerably increase the number of nodules, the effect upon the crop is not appreciable, and it is hardly worth the expenditure of time and labor necessary to make the inoculation. Wherever legumes that fail to produce tubercles are being grown, however, or in those localities where the soil is so poor that legumes will not grow and because of the lack of the proper organisms they can not make a start, every effort should be made to get the bacteria into the soil.

SYSTEMS OF FARM MANAGEMENT IN THE UNITED STATES.

By W. J. Spillman,
Agrostologist, Bureau of Plant Industry.

Introduction.

The most successful system of farming is that which gives the largest profit, leaves the soil in condition to yield maximum crops, and brings to the farmer and those dependent on him the largest measure of happiness. In conducting a farm upon such a system, the farmer must continually answer for himself the questions: What crops shall I grow and what area of each? What care shall I give these crops and the soil upon which they grow? What disposition shall be made of the produce of the fields? If the crops are to be sold, then when and where? If they are to be fed, then to what classes of stock and to what number? What manures and fertilizers shall be applied to the soil, to what crops, in what season, in what quantities? What provision shall be made for the protection of growing crops from insect pests and fungous diseases, for storing crop products, for the protection and care of live stock? When and where shall live stock and their products be marketed? The repeated answering of these and other similar questions constitutes farm management—a business in which is found the application of many sciences, but a business so broad and complex that it must rest mainly on the accumulated experience of generations of those who have followed it. Conditions of climate, proximity to market, the character of farm labor, social conditions, and that great enigma, the soil, have all been determining factors in the development of the systems of farming that have been gradually evolved in the various sections of the country. These systems for the most part have been worked out in a purely empirical manner, and have always followed lines of least resistance. This or that crop or system of cropping has become established because it furnished the greatest immediate returns, and has remained even when it became unprofitable because of the natural conservatism of the farmer. Frequently a system established by one generation has been bequeathed to the next, to its financial undoing. One of the principal reasons for this state of affairs lies in the fact that the American farmer has until

recently been drawing on soil resources accumulated by natural processes through long ages; he has not been compelled by force of circumstances to learn how to conserve the fertility of the soil. Land has been so plentiful and so cheap that when one field was exhausted he simply transferred his operations to another. No cause for alarm was felt so long as "Uncle Sam was rich enough to give us all a farm" on the fertile prairies of the unbounded West. But conditions have changed. Most of the farm lands of the West have been occupied, and the new generation finds itself under the necessity of earning a livelihood on the lands of its forefathers. In all the older sections of the Eastern and Southern States the problem of restoring the soil to its original fertility is a pressing one. Had the farmer been left to his own resources in working out this problem, agriculture would undoubtedly by this time have been in a deplorable condition. As it is, much land has been abandoned, and the profits of agriculture are very small in some regions where farming was formerly highly profitable.

WORK OF THE INVESTIGATOR FOR THE FARMER.

Fortunately the development of the agricultural press, the farmers' institute, the experiment stations, the schools of agriculture, and the Department of Agriculture during the past quarter century have contributed to the general dissemination of agricultural knowledge. These agencies have probably averted a period of agricultural depression such as afflicted England during the period which gave rise to the "corn laws." Heretofore the aid which the farmer has received from agricultural investigators has been mainly in the line of laboratory studies of chemical, physical, and physiological problems. In this way much has been learned concerning the principles involved in the production of crops, the conservation of soil fertility, and the feeding of animals. The farmer has been left largely to himself in changing his plans to fit the suggestions offered him. Too often he has been compelled to change the suggestions to fit his plans. Too little attention has been paid to the subject of farm management. A careful study of the systems of farming in vogue in all parts of the country would not only show what are the real problems that confront the farmer, but would reveal the fact that farmers themselves have already solved many very important ones. Such a study would show that in one locality there is no problem more pressing than the dissemination of the knowledge we have, and that the investigator is free to take up those fundamental problems which deal with general principles, such as the principles of nutrition, the principles of breeding, etc. Elsewhere the one great problem is the stocking of the soil with humus. The experimenter can aid the farmer in choosing the proper crops for this purpose. Again, the problem is to find a crop adapted

to peculiar soil or climatic conditions, and so on. But when these problems have been solved in the laboratory or in experiment plats, there remains the problem of readjusting the system of farming. Heretofore the farmer has been left to himself in this matter, and frequently he has been slow to avail himself of the results of investigation because the problem has been too large for him. For instance, the cotton growers of the South have long recognized the necessity of introducing leguminous crops into their rotations to secure much-needed humus. But these crops can only be utilized as feed for stock. This means that the farmer must learn the characteristics of the various breeds of stock and how to care for live stock, all of which is new to him. He must have pastures, and he is not familiar with the grasses and the management of pasture lands. Again, much of the land is leased in small lots to negro tenants who are familiar with the cultivation of no other crop than cotton, or perhaps corn. It is therefore necessary, in order to secure the benefits from humus-producing crops, to revolutionize the system of farming and to change wholly the relation that has heretofore existed between landlord and tenant.

When crops adapted to the climate and soil and capable of building up the soil have been found, shall the farmer be left to readjust his system to fit them, or shall an effort be made to help him in this readjustment? To give this help the experimenter must first make himself familiar with the peculiarities of the soil and its management, climate, market conditions, character of available labor, social conditions, the character of the available live stock, and the conditions which must determine its management—all those factors that govern present practice and which must govern the new system. It is easily seen that the adoption in practice of the results of investigation may be a much larger problem than the investigation itself. These broader problems can not be taken into the laboratory; neither can they be solved by plat experiments, though these means will aid in their solution. They do not always lend themselves to laboratory methods, but require rather the methods of the statistician.

BENEFITS OF A STUDY OF FARM CONDITIONS AND FARM METHODS.

Here and there in all parts of the country farmers can be found who are highly successful. True their success is generally due to unusual executive ability; but this is simply saying that they have answered the questions propounded in the above definition of farm management and answered them correctly for their conditions. There is no more fruitful field of study than the methods and results of these men. It will usually be found that they can give satisfactory reasons for the system of farming they follow and the methods they employ. Comparison of their methods with those of other successful farmers will often give the clew to principles that underlie successful practice.

There is no question that farmers everywhere would benefit by a knowledge of the methods pursued by the most successful of their fellows. Few can be originators; the majority must be imitators; hence the value of the suggestions gained by a knowledge of what others have done and are doing. The agricultural papers have realized the importance of this. Some agricultural writers have undertaken to study farm conditions and farm methods over large areas of country, with great benefit to their readers, particularly where these writers have had sufficient training and knowledge to make their deductions reliable. This study should be taken up more seriously. It should include a study of methods pursued on all classes of farms, both successful and unsuccessful, and should extend over the whole country. With the knowledge thus gained one should be in position to recognize the leading problems that confront farmers in all sections, to know what changes in farm practice are needful, and to understand how these changes may best be accomplished. With these ideas in mind, the writer during the summer of 1902 visited several widely separated agricultural sections for the purpose of studying the methods of farm management in vogue in those sections. In the present paper the methods on only a few of these farms can be given, and in order to present possible conditions and make practical recommendations only actual practices on these individual farms will be described.

Before proceeding to give the details of the management of these farms a few generalizations seem to be justified by the facts at hand. These facts tend to confirm the principles that have been advocated by leading agriculturists for many years. The agricultural sections which are most prosperous are those in which these principles are most closely followed.

TYPES OF FARM MANAGEMENT.

It would perhaps be premature to attempt a classification of the various types of farm management that prevail in different sections of the country. In fact the systems followed on different farms represent every gradation between the farm where a single crop is grown and the product is all sold off the farm, and that on which no crops are grown, but large quantities of feed are bought and fed, if indeed the latter may be called a farm. Nevertheless certain types may be more or less arbitrarily chosen, and each farm classed under one of these types, or considered as intermediate between them. It may be safely assumed that the development and maintenance of soil fertility is the most important problem in farming. With soil fertility assured the future of agriculture may be considered safe. Types of farm management may therefore be established on the basis of those practices which relate to soil fertility. On this basis three general types may be assumed.

(1) LIVE-STOCK FARMING.

In its best development, this type of farming makes every other consideration secondary to live stock. The crops raised are practically all fed on the place, and the resulting manure is carefully utilized. Frequently more is fed than is raised on the farm, either grain or hay, or both, being purchased. When intelligently managed this system invariably results in building up the soil to the highest state of fertility. In sections of the country where it has been followed for many years there is even complaint that the land is becoming too rich for wheat and oats, since these crops, with the rank growth that occurs on exceedingly rich land, tend to be weak in the straw, and wheat particularly goes too much to leaf and too little to grain. On farms of this type commercial fertilizers are used sparingly or not at all.

These live-stock farms may be divided into subtypes, such as general live-stock farms, on which several kinds of stock are kept, no one kind having a decided preference; dairy farms; and special live-stock farms, on which one kind of stock is made a specialty. Dairy farming might be included in special live-stock farming, but it has so many distinctive characteristics that it needs to be considered separately. Every gradation between these three subtypes will of course be found. Market gardening, in which large use is made of manure obtained from cities, may be considered as intermediate between this type and the next.

(2) GRAIN AND HAY FARMING.

This is a type that has grown up in certain sections where live stock has gradually disappeared, and more and more of the energy of the husbandman is devoted to the production of grain, potatoes, hay, etc., for the market. The essential feature of this second type of farming lies in its reliance on the roots and stubble of ordinary crops, including grasses and legumes grown for hay, or catch crops to be turned under as green manure, to maintain the supply of humus and nitrogen in the soil, while the mineral elements of plant food are largely supplied in commercial fertilizers. This is the system employed by many farmers in Ohio, Pennsylvania, Maryland, and New York. The farmers in this region have been driven to this system by force of circumstances. For the following facts bearing on this point the writer is indebted to Director C. E. Thorne, of the Ohio experiment station. During the eighties the price of live stock in Ohio suffered a serious decline, coincident with the opening of the Western ranges. About the same time improvement in machinery for handling grain greatly reduced the cost of producing this class of crops. The ease with which grain is marketed also contributed to the development of grain growing. Many farmers were rendered bankrupt by the decline in prices of live stock, and they naturally turned to grain growing because less capital was

required in that style of farming. A few years later the development of grain growing in the Northwest reduced the price of grain, thus leaving the farmers without recourse. As a result agriculture was at a very low ebb and land values shrank nearly one-half. The turn came with the recent advance in the value of live stock, but it found many farmers without the capital required to take advantage of improved conditions. Director Thorne estimates that the amount of live stock in Wayne County, Ohio, is now about half what it was in 1870, and that $40,000 a year has been added to the bill for commercial fertilizers.

Similar conditions prevailed in all the great live-stock regions of the East. The dairy industry in this country had its birth about the time this depression began, and it proved to be the salvation of many farms. But many farmers found dairying either uncongenial or were not in a position to adopt it. As a result, a system of farming has developed which depends upon a proper rotation of crops, or upon catch crops and green manures for humus, and commercial fertilizers for mineral plant food. The ultimate effect of such a system upon the fertility of the soil has not yet been satisfactorily demonstrated. Any system which results either in rapid improvement or rapid deterioration of the soil may have its merits or demerits established in a comparatively short time. But a system which has no radical tendency in either direction must be studied through a long series of years to determine its ultimate effect. It has been quite generally assumed that unless a large proportion of the crops (the amount depending upon the strength of the soil) is fed on the farm, the fertility of the soil can not be maintained. It will perhaps be conceded that a worn-out soil can not easily be brought back to its original fertility without the aid of live stock. At any rate such a process could be much more easily accomplished by feeding the crops and returning the manure to the land than in any other way, unless indeed farmers simply grow crops, especially legumes, and turn them under again. But where a soil is already in good condition, intelligent management has enabled farmers in the section referred to to maintain good yields for a generation at least by the methods outlined above. Too often, however, this system degenerates into the original system of soil robbery practiced on all new and fertile lands the world over since agriculture had its beginning.

(3) NONHUMUS FARMING.

A third type is that in which no attention is given to the supply of humus in the soil. Commercial fertilizers may or may not be used. This type is found in a pure state in some of the newer wheat-growing regions of the Northwest and the Pacific States, where the rich prairie soils are not yet exhausted and where no fertilizers are used, as well

as in the single-crop cotton-growing sections of the Gulf States. In the latter, commercial fertilizers are used extensively in the older sections and the regions of lighter soils, but only moderately or not at all in the newer or richer soils of the western portion. The vast majority of farmers in these two sections make no effort to keep up the stock of humus in the soil. The same is true of thousands of individual farmers scattered over all parts of the country.

The effects of this system are too well known. In order to maintain the fertility of the soil two things are absolutely essential: First, the soil must be kept stocked with a sufficient supply of decomposing organic material (humus) to keep it mellow and porous enough to permit of the free circulation of air and moisture; second, the soil must be supplied with sufficient mineral plant food to meet the requirements of crops. There are in general two ways of doing both these things. Humus and plant food may both be supplied by feeding more or less of the products of the soil, the proportion depending on the character of the soil itself, and returning the manure to the land; or the humus may be supplied by frequent cropping with grass and legumes or by green manures, and the mineral plant food by the use of commercial fertilizers. The first of the three systems described above uses the first and more certain of these two methods; the second system uses the last method. The third system makes no provision for a constant supply of humus, and frequently none for mineral plant food. Experience has demonstrated that no amount of plant food will compensate for a lack of humus, and lack of attention to this requirement accounts for the numerous abandoned farms in all the older sections of the country.

DISTRIBUTION OF THE THREE SYSTEMS OF FARM MANAGEMENT.

In this discussion the arid and semiarid areas devoted solely to grazing are not considered. On the irrigated lands of the Far West the second type, or grain and hay farming, prevails. No fertilizers are used ordinarily, but the supply of humus is kept up mostly by the cultivation of alfalfa and other crops. The effect of irrigation water in bringing plant food to the soil is not yet fully known, but it is probably considerable. The ultimate effect of present methods on these soils, which are all new and for the most part naturally fertile, remains to be seen. It is probable that the accumulation of salts in the soil will be more important in future on these soils than the exhaustion of fertility. The third type is found not only in those sections where single-crop systems prevail, but on individual farms all over the country. The system of live-stock farming does not cover whole sections solidly in any part of the country, but is more or less characteristic of all those parts of the country that have never been so unfortunate as to find a single crop that would make men rich in a

few years. Where such crops have been discovered, they have invariably led to the general adoption of wholly unscientific systems of farming, which sooner or later lead to financial ruin.

In the main, general live-stock farming and the style of farming having beef production as its principal feature are characteristic of the great corn, oat, and clover region of the Upper Mississippi Valley. Other types of special live-stock farming are common in the same region, such as those in which horses or swine are the principal source of income. These special types are also common in all the region east of Illinois and north of Tennessee and Virginia. Isolated cases occur in the Southern States and on the Pacific coast. Dairy farming is best developed in the northern tier of States, on the whole Pacific coast, and in certain of the States of the second tier, notably Iowa. That style of farming which depends on frequent crops of grasses and legumes to keep up the supply of humus, making little use of live stock and which uses an abundance of commercial fertilizers, is found mainly north of Virginia in the East and Tennessee in the West, and east of Illinois, as already stated. It has its fullest development in Maryland, Pennsylvania, and New York.

The distribution of these various types has evidently been largely the result of the adaptability of soil and climate to certain crops. The cotton crop has determined the development of agriculture in all those regions adapted to its cultivation. It will always have an important influence in those regions, as it should. The fact, however, that it long ago excluded other excellent crops leaves us without a proper knowledge of the adaptability of the cotton-growing sections to other crops and to live-stock farming. The adaptability of the wheat plant to the prairie soils of the Northwest and the Pacific Northwest has determined until now the course of agricultural development in those regions. Corn, clover, and oats are responsible for the general prevalence of live-stock farming in the Upper Mississippi Valley, while wheat, corn, and timothy and clover, together with market conditions, are largely responsible for the systems that prevail in the East Central States. A marked instance of the adaptability of a crop to a given soil and the resulting influence on agriculture is found in the case of bluegrass in Kentucky. Taking a point 25 miles north of Lexington as a center, with a radius of approximately 55 miles, if we describe an arc of a circle in Kentucky, with both ends of the arc resting on the Ohio River, we shall include that part of the State the soil of which was formed from the dolomitic limestones of the Cambrian era. This area is the far-famed "bluegrass region" of Kentucky. Outside of it bluegrass is of no importance in that State. There is no question that the adaptability of bluegrass to this particular soil accounts for the great stock farms of the State, which are practically confined to this area.

It is not difficult to point out certain changes in prevailing systems of farming that are necessary to agricultural prosperity, both present and future. It is not so easy to indicate how these changes are to be brought about. In general, efforts in this direction must first be given to methods of supplying humus to soils deficient in this all-important constituent. This means the more general cultivation of grasses and forage crops; and since these crops must necessarily be utilized as food for live stock, and since such use of them on the farm adds greatly to the possibilities of increasing the supply of humus, it follows that a change toward live-stock farming in regions where it is now unimportant would be the most promising means of improving the soil and restoring permanent prosperity.

In this connection, certain facts revealed by the census of 1900 are not without interest. Fig. 34 shows the relative value of the live-stock

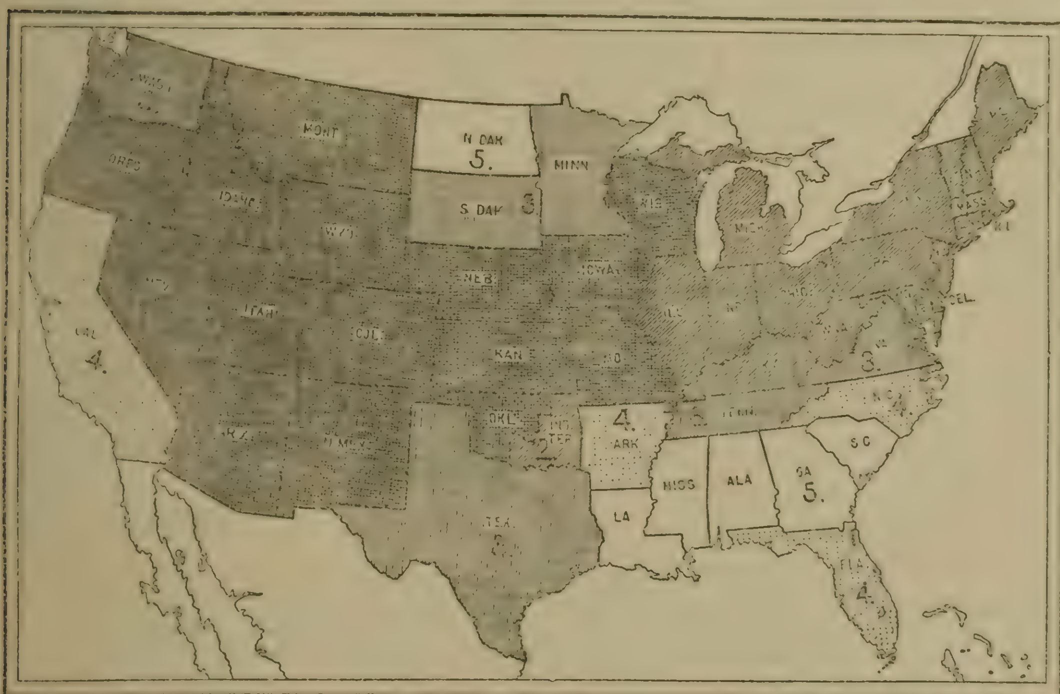


FIG. 34.—Percentage of live-stock products in total farm products: (1), darkest shading, 42 per cent and over; (2) 35 to 42 per cent; (3) 28 to 35 per cent; (4) 21 to 28 per cent; (5), with no shading, less than 21 per cent. (Compiled from census of 1900.)

products of the various States. The group of States most deeply shaded includes those in which the live-stock products exceeded 42 per cent of the total farm products. In addition to the Mountain States, this group includes Oregon, Nebraska, Kansas, the Indian Territory, Iowa, Missouri, and Wisconsin. The preponderance of live stock in the Mountain States is, of course, due to the fact that range stock constitutes their principal agricultural resource. The stock on the range lands of eastern Oregon doubtless account for the position of this State in this class also. California is excluded by her wheat fields and fruit interests, while Washington, Minnesota, and the two Dakotas are

excluded from this class by their immense wheat fields. In the next group of States, extending from Illinois to Maine, live-stock products constitute from 35 to 42 per cent of the total farm products. Had it been possible to subdivide States in this discussion, much of Illinois and part of Indiana would have been classed with Iowa and Wisconsin. In the northern and eastern portion of this second group of States live-stock interests relate largely to dairying; in the western, to dairying and beef production; and in the southern, to horses and beef production.

The third group of States consists of Washington, South Dakota, Minnesota, Texas, Tennessee, Virginia, Maryland, and Delaware. In these, live-stock products constitute from 28 to 35 per cent of the total

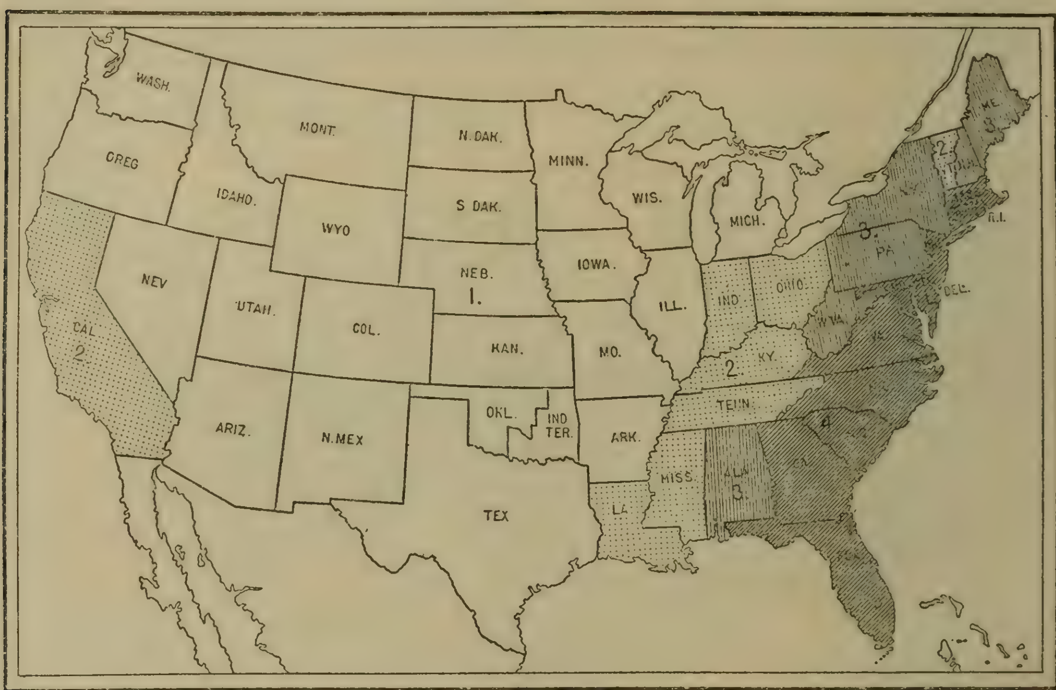


FIG. 35.—Proportion of value of crops expended for commercial fertilizers: (1), unshaded portion, less than 1 per cent; (2), lightest shading, 1 to 3 per cent; (3), medium shading, 3 to 5 per cent; (4), darkest shading, 5 to 10 per cent.

farm products. The anomalous position of Texas in this group is due to the fact that, while western Texas is devoted exclusively to stock raising, the central and much of the eastern portion is devoted mainly to cotton.

The fourth group, in which the live-stock products constitute 21 to 28 per cent of farm products, consists of California, Arkansas, Florida, and North Carolina.

The fifth group, in which the live-stock products are less than 21 per cent of the total, includes North Dakota and the cotton-producing States of Louisiana, Mississippi, Alabama, Georgia, and South Carolina.

In fig. 35 the relative amount of commercial fertilizers used is shown. In the unshaded area the fertilizer bill is less than 1 per cent of the

value of the crops. It is less than one-half of 1 per cent in all these States except Michigan, where it is less than six-tenths of 1 per cent. What little fertilizer is used in these States is applied mostly to truck crops, the general farmer being ordinarily unacquainted with commercial fertilizers.

In the second group, extending from Ohio to Louisiana and including California, the expenditure for fertilizers amounts to 1 to 3 per cent of the value of the crops. In Maine, New Hampshire, New York, Pennsylvania, and Alabama the fertilizer bill is 3 to 5 per cent, and in the remaining States over 5 per cent of the value of the crops. In the two Carolinas, Maryland, Delaware, New Jersey, Connecticut, and Rhode Island over 7 per cent of the value of farm crops is used in the purchase of commercial fertilizers, and nearly 7 per cent in Georgia and Virginia.

These maps (figs. 34 and 35) furnish some interesting suggestions regarding the relation of live-stock farming to the use of commercial fertilizers. In the first place the use of commercial fertilizers has developed to large proportions in the older sections of the Atlantic seaboard and is gradually extending westward. But in its westward course it has plainly swerved toward the region in which stock farming is unimportant and away from the live-stock regions. Doubtless the course followed is partly due to differences in soil, but there can be no doubt that live-stock farming is a very important factor. Reference has already been made to the fact that during the last twenty-five years, owing to the cheaper production of beef cattle in the West in connection with the perfection of machinery for handling grain and hay crops, Wayne County, Ohio, has lost the equivalent of 12,000 head of cattle (half its live stock) and increased its annual fertilizer bill by $40,000, and that these changed conditions are typical of those in the State generally. According to Director Thorne, during the twenty years preceding this change the average yield of wheat in Wayne County increased from about 14 bushels to about 16½ bushels per acre; while during the last twenty-five years the average yield has been at a standstill, with a tendency in later years to decrease.

The very opposite of this condition prevails in parts of Wisconsin, New York, and Vermont, and other regions where the dairy industry has been greatly developed in the last quarter century. It is generally conceded that where the major part of the farm is devoted to the production of forage crops that are consumed on the farm the soil is growing richer; while in those regions where such crops are not grown and where commercial fertilizers are practically the sole reliance, the productivity of the soil has been greatly lessened. It will be noticed (see fig. 35) that in Vermont the development of the dairy industry has had considerable influence in lessening the use of commercial fertilizers.

Typical Farms.

Since space will not permit the consideration here of the methods of management on farms of all types, those selected have been chosen with a view to showing how much diversity there may be in the means adopted in carrying out essentially the same idea, namely, that nothing shall be sold off the farm that would tend to rob the farm of fertility. Each of the farms selected represents a different subtype of pure live-stock farming. This class of farm is chosen purposely, because it represents the type which will most quickly build up worn-out soils. The management of the three farms of this type described is given in more or less detail, the first being a general live-stock farm, with beef production a leading feature; another purely a dairy farm, while the third is devoted to the feeding of Western range lambs and to the care of a flock of pure-bred sheep. The cropping systems followed on these farms are widely different, and one of them at least is situated on land that was at one time not as fertile as it now is. But they all agree in this one feature, that is, that all the crops produced are fed on the place, while on the last two in particular large quantities of feed in addition to that produced on the place are bought and fed.

A GENERAL LIVE-STOCK FARM.

As an example of a general live-stock farm we will take that of E. E. Chester, of Champaign County, Ill. This is situated on the rich, black prairie soil of northeastern Illinois, where corn, oats, and clover are at their best, and hence exert an important influence on methods of farming. About the same system of cropping has been pursued on this farm for the past twenty years, so that we have an opportunity to observe the effects of the system. The owner endeavors to keep enough stock to consume all the products of his farm, and to put it in his own language "takes the chances of keeping a little more and buying some feed, though some feed is sold in exceptional years." He has a 100-ton silo, the contents of which he utilizes in steer feeding, and finds it highly advantageous. Silage reduces the amount of hay required. He both raises and buys for feeding purposes horses, cattle, and hogs. He uses no commercial fertilizers of any kind. When the writer spoke of desiring to learn the methods of successful farmers in various parts of the country, Mr. Chester very quickly asked what was meant by a successful farmer, and was satisfied with the definition that a successful farmer is one who makes his farm profitable without impoverishing the soil. To quote him again: "There are two kinds of successful farmers. One is only so called, for he makes money by impoverishing his soil; the other keeps up the fertility of the soil."

THE ROTATION.

The rotation on this farm is very elastic, depending on the needs of the live stock, the condition of the soil in the different fields, and the success or failure of the seeding of grass. The permanent pastures consist of bluegrass, while third-year and fourth-year (sometimes fifth-year) timothy and clover sod is used for temporary pasture. In all there are usually about 200 acres (slightly more than one-third of the arable land) in pasture. Corn is the leading cultivated crop, the usual area being about 140 acres. Part of the corn is planted on corn land of the previous year, the remainder on clover or timothy and clover sod. The amount of such sod broken up for corn each year is 30 to 50 acres. Corn is grown on the same land two or three years in succession. Each fall about 20 acres of corn land is put into wheat, the principal object of the wheat being to "have a good place to sow timothy." In the spring about 35 acres more of the corn land is put into oats with clover. Clover is also sown on the wheat in the spring, care being taken to get clover seed on the vacant places where the corn shocks stood when the wheat and timothy were sown. Oats are also sown on any bare places that may appear in the clover field, and are cut with the clover for hay. Pure clover is left down two years, and mixed timothy and clover about four or five years. The following shows approximately the rotation practiced on this farm during two successive seasons:

Approximate rotation on the Chester farm.

1901.		1902.	
Acres.	Crops.	Acres.	Crops.
100	Bluegrass pasture	100	Bluegrass pasture.
140	Corn	90	Corn.
		30	Oats.
		20	Wheat.
100	Timothy and clover pasture	50	Corn.
		50	Timothy and clover pasture.
50	Timothy and clover meadow	50	Timothy and clover pasture.
30	Oats	30	Clover.
20	Wheat	20	Timothy and clover.

As there is no fixed order in which corn land is to be put into wheat and oats, and timothy and clover sod broken up for corn, it is not possible to represent this rotation by fixed boundaries. This is a rotation governed by mature judgment, based on the needs of the soil and the stock that are to consume the crops.

Corn.—This is the leading crop on this farm. Mr. Chester is a member of the Illinois Corn Breeders' Association, and in addition to growing corn to feed his stock he is improving his seed corn by

careful selection, and in recent years has sold part of his corn crop for seed at a price that he thinks justifies him in breaking his rule not to sell his crops. He pays particular attention to the selection of corn with a view to increasing its feeding value; that is, increasing its nitrogen content. In this work he is cooperating with the Illinois experiment station.

Sod intended for corn is plowed in late fall or early winter, after the summer's heat is past. The manure is plowed under here. Most of the manure produced on the farm is drawn out directly from the barn as made and placed on sod to be broken up for corn. Some of it necessarily accumulates, owing to bad weather, pressure of work, etc.; this is drawn out in August. A manure spreader is used, one man getting out 6 to 8 loads a day on the average.

After filling a 100-ton silo, about 40 acres of corn are cut for fodder. The silo holds the corn of 10 to 12 acres. The average yield of corn for the past forty years on this farm is a little over 50 bushels per acre. This includes good and bad years alike. An ordinary good yield is considerably more than this.

WHEAT AND OATS.—As previously stated, wheat is grown only to give a proper seed bed for timothy. The latter crop requires to be fall sown in this section. The wheat is used for feed. It is particularly valuable for pigs and poultry. The writer has fed wheat in large quantities for many years and fully agrees with this statement. The average yield of wheat for the past forty years is about 20 bushels per acre. This is evidently not typical wheat soil, and it is probable that the yield of straw is relatively larger than the yield of grain—a frequent occurrence on land too rich for wheat.

Oats are grown for feed only. The yield is from 25 to 85 bushels, averaging about 50 bushels.

TIMOTHY AND CLOVER.—Timothy is not as much grown in this section as formerly, many farmers not sowing it at all; not that it is not appreciated, but it does not fit into the system of farming except where wheat is grown, and, as already stated, wheat is not entirely at home here. On this farm timothy is sown in the fall with wheat. In the spring clover is sown on the same land, thus giving a stand of clover in the bare places where the corn shocks stood. Clover is also sown with the oats. This clover is left down about two years and is cut for hay. The mixed timothy and clover is cut for hay two seasons, and then used for pasture two or three seasons.

The yield of hay is 1 to 3 tons per acre, averaging about 2 tons. With a liberal use of manure, an average of 3 tons is possible. About 50 acres of hay are cut each year. Corn always follows these crops, the sod being well manured before breaking.

BLUEGRASS.—This is used for permanent pasture. Bluegrass sod is seldom broken up, but the owner of this farm is of opinion that

it accumulates so much fertility that it is best to crop it once in a while, so that occasionally a portion of the bluegrass sod is broken up and run through the usual rotation, another portion of the farm being set in bluegrass to take its place. The owner pastures bluegrass early in the season, but usually markets stock enough to give the grass comparative rest during summer, using it again in fall and winter. Last year cattle were kept on bluegrass till January.

Bluegrass seed is sown in February, in order to give it the benefit of freezing and thawing. This insures the covering of the seed.

MANAGEMENT OF LIVE STOCK.

CATTLE.—Cattle are the first consideration on this farm, there seldom being less than 100 head. A herd of high-grade Shorthorns has gradually been changed into a herd of registered stock. By this means the value of the calves at weaning time has been raised from an average of $15 to an average of $100 a head. In recent years many cattle have been sold for breeding purposes. Steers are also bought and prepared for the market. Only good calves, yearlings, and two-year-olds are bought for this purpose. In buying, preference is given to young, light cattle in order that the flesh may be put on them on the farm. Mr. Chester prefers to buy a steer at 500 to 800 pounds, rather than at 1,000 pounds. When asked his method of handling calves for beef, he replied: "Never let them get hungry; but make their feed as cheap as possible till the fattening period, then stop cheapness." In the writer's opinion this sums up the principles involved in the economic production of prime beef so tersely that it deserves to be remembered. Before the fattening period begins the feed consists of pasture, cornstalks, clover hay, and silage. When the steer reaches about 1,000 pounds the fattening period begins. Several lots of one or two carloads each are fed off annually, a lot being on feed most of the time. The early winter feed of fattening steers consists of 20 to 40 pounds of silage, one-fourth to one-third bushel of corn, and all the clover hay they will eat. The corn is snapped (broken from the stalk) and is crushed—cob, husk, and grain all together. In summer, fattening steers are put on bluegrass and given about a peck of corn a day each, either crushed or in the form of fodder (stalk, leaves, and ears all together). A lot of steers were put on feed in March, 1902. When on full feed they were given 40 pounds of ensilage and a peck of corn daily, with all the clover hay they would eat. The gain during March and April averaged 3 pounds per head per day. At the end of April they were put on bluegrass, with a peck of corn a day, and fed thus till June. At the time of the writer's visit (June 30, 1902) the results had not been figured up. but Mr. Chester believed they were satisfactory. The usual length of the

feeding period on this farm is from one hundred to one hundred and twenty days.

Many farmers fail to see where the profit lies in feeding steers. In the case mentioned, if we assume that silage is worth $1.50 a ton, corn 30 cents a bushel, and clover hay $8 a ton, the gain costs, approximately, 5 cents per pound. For the sake of comparison, let it be assumed that the fattened steer sells at the same price per pound he would have brought before fattening, and that this price is 4 cents per pound. The results for a 1,000-pound steer fed up to 1,300 pounds would then be as follows: Value of original carcass, $40; value of finished beef, $52. The gain here of 300 pounds adds $12 to the value of the steer. This gives a return of 4 cents a pound for the flesh added. If we assume the finished steer to be worth a cent a pound more than the stocker, we have $15 for the increased weight, plus $10 increased value on the original weight. Here the addition of 300 pounds in weight has added $25 to the value of the steer. The feeders, therefore, received 8⅓ cents a pound for the gain. If the difference in value per pound before and after fattening is 2 cents, we get $18 for the increased weight and $20 for the increased value of the original weight, or 12⅔ cents a pound for the gain. The question, therefore, is whether the value of the added flesh, plus the increased value of the original weight, is greater than the cost of gain. If it is, there is a profit. In the last case assumed, namely, where the values before and after fattening are 4 and 6 cents, respectively, a cost of 10 cents per pound of gain would still have left a profit of 2⅔ cents per pound of gain.

Hogs.—There are seldom fewer than 100 head of hogs on this farm. These are kept on pasture as much as possible, but are fed grain the year round, except when following cattle on feed. Hogs are sold at about 300 pounds. As soon as spring litters are old enough, the sows and pigs are put after cattle on pasture. As much of the growth of pigs as may be is made on pasture.

Horses.—Some 20 head of horses are kept, about twice as many as are needed for work, the idea being to make the profit on horses pay for the horse power used on the farm. As is the case with all other classes of stock, horses are both raised and bought. With the exception of a driving team, the horses are all high-grade draft animals, and are always sent to market in prime condition. No exercise is given while fitting for market except to lead them out three times a day for water. When put on feed to be prepared for market, horses are given all the clover hay they will eat and a gradually increasing ration of corn and oats till they have all they will eat up clean. In season green corn is used instead of dry, the change being accomplished by substituting one ear of green corn for one of dry each day.

Mares are sold off before they become old, unless they have exceptional breeding qualities.

Regarding the classes of horses for a farmer to handle, Mr. Chester believes the average farmer should stick to the draft breeds. If he needs road horses, it is better to buy them. Road horses must be trained before they are ready for market.

SHEEP were formerly kept on this farm, but the owner dropped them because he had too many lines to look after.

A DAIRY FARM.

Only one strictly dairy farm, namely, that of T. E. Ellison, Allen County, Ind., was included in the list of farms visited by the writer in this investigation. This was due to lack of time to visit the more important dairy sections. The Ellison farm is located on rich alluvial soil in what was once the bed of a broad preglacial river. The soil is heavily charged with organic matter, and is drained by large, open ditches. As on the Chester farm, all the crops are fed and much additional feed is purchased. No regular rotation is practiced, the manure being placed where it seems most needed. A spreader is used, and the manure is drawn to the fields as it is produced. A little less than one-third of the arable land is in bluegrass pasture, the area of this pasture being about 105 acres. About 100 head of registered and grade Jersey cows and about 75 head of young stock are kept. No breeding stock is sold, the farm being run strictly as a dairy farm. The heifer calves are raised on skim milk, clover hay, and bluegrass pasture. About 100 fat hogs are sold annually. Six brood sows raise two litters a year each. The pigs are marketed at about 225 pounds. These pigs are fed buttermilk, rape, and corn. Sows with litters are fed all the rape they will consume, with a little grain and buttermilk. An acre of rape is sown in April near the pens, and furnishes two crops a year. It is cut and fed twice daily. These hogs were evidently in thrifty condition. This method of handling them is suggestive, as it is somewhat unusual. Thirteen head of work horses are kept on the place. The principal crop is corn, of which some 170 acres are grown annually. This crop is grown on the same land four or five years in succession, with manure applied as it seems to be needed. The average yield is about 60 bushels per acre. Five seasons the yield has been over 100 bushels. Corn land is plowed in spring, harrowed twice with a spring-toothed harrow, and rolled. After the corn is planted, a drag harrow is run over the field before the corn is up. This treatment frees the land from weeds and leaves it in good condition for the later cultivations. Forty to 50 acres of corn are cut for silage, filling a 650-ton silo. Ensiling begins about the middle of August. When the silo is full the remainder of the crop is shocked,

husked, and all the stover shredded. Mr. Ellison is of opinion that this shredded fodder accounts for a larger share of the profits from his farm than any other one thing. Two varieties of corn are used, one earlier than the other, in order to prolong the cutting season.

Twenty acres of oats are grown and all cut for hay, the yield being 3 to 4 tons per acre. This crop is always grown on land previously in corn, and clover is sown with the oats. Formerly a few acres of wheat were grown, under the impression that clover could be more safely started with wheat for a nurse crop than with oats; but experience on this farm indicates that this is not the case. Wheat lodges badly on this soil, and its cultivation is to be abandoned in favor of oats.

A first cutting of 20 acres of clover and a second cutting of 15 acres produced 62 large loads of hay, probably considerably over a ton each. Clover sod is plowed up for corn at the end of the second year.

Mr. Ellison has been experimenting with alfalfa recently, having sown 10 or 12 acres on April 16, 1901, using 20 pounds of alfalfa and 1 bushel of oats per acre. This crop yielded three cuttings the same year, the first, cut June 20, being mostly oats; the second, cut August 1, mostly alfalfa; and the third, cut September 20, all alfalfa. These three cuttings combined gave over 4 tons per acre. At the time of the writer's visit (July 4, 1902), the crop had been cut once and was then 6 inches high, with a perfect stand, and very thrifty. Mr. Ellison states in a recent letter that his farmer considers alfalfa equivalent in feeding value to bran, and that he will sow 40 acres of it next spring. Soy beans have been tried on this farm but did not succeed. A few acres of potatoes are grown for market. Two acres grown last year yielded over 700 bushels per acre.

Some 50 to 60 tons of bran and gluten meal are fed annually on this farm, in addition to all crops grown, except potatoes, and the resulting manure is distributed where most needed. It is safe to say that this soil will not soon wear out with this treatment.

The owner of this farm also conducts a dairy business in a neighboring city, where he has an extensive trade in butter, ice cream, and pasteurized cream and milk. He therefore has excellent facilities for marketing the principal product of his farm—milk. The net profits from the farm last year were over $8,000.

A SHEEP FARM.

The farm of Joseph E. Wing, of Champaign County, Ohio, the well-known agricultural writer, is an excellent example of a special type of live-stock farming. It is noted both for its sheep and for its crops of alfalfa. Mr. Wing learned the value of alfalfa while ranching in Utah. Having returned to his native State, in 1890 he sowed one-third acre of this crop. Finding it successful, he gradually

extended the area until he now has 100 acres of excellent alfalfa, from which he cuts three crops of hay a year. He regards it as the most profitable crop he grows. The soil of this farm is for the most part the ordinary upland glacial soil of that section, part of it being decidedly gravelly. It is not naturally a strong soil, but it has been demonstrated that it will produce abundant crops when intelligently managed. Mr. Wing asserts that manure is absolutely essential to profitable farming on this soil. Although located in a wheat-growing section, no wheat is grown on this farm. The owner states that he never made any money farming till he abandoned wheat and timothy. He follows no particular rotation, but suggests the following as a feasible one for his section: Alfalfa four years, corn one year, and beardless barley one year. The barley is used as a nurse crop for newly seeded alfalfa, but in case chinch bugs are troublesome he would dispense with the barley and sow the alfalfa alone. Beardless barley yields 30 to 60 bushels per acre in the region in question. Being an early crop, it can be removed in time to allow the alfalfa to make considerable growth the first season. It will be remembered that alfalfa was seeded successfully with oats on the Ellison farm, previously described.

The three crops in the rotation suggested above are the only crops grown on the Wing farm. Regarding the cost of labor, Mr. Wing states that ten years ago, with 200 acres, $200 was expended for labor in addition to the labor of the owner. The gross sales from the farm at that time were about $700 a year. At the present time, with 260 acres, the annual labor bill is $1,500, while the net profits are more than $2,500.

Alfalfa.—This is the leading crop on this farm. It is sown with barley (beardless) on land previously in corn. To insure a stand the land should be well manured for the previous corn crop, but land can be too rich for it. Mr. Wing states that it did rather poorly on old garden soil. When once established it is left down four or five years. He has occasionally plowed up alfalfa fields because they were invaded by bluegrass. In ten years he has plowed up 75 acres, always following with corn. In all cases the yield of corn is greatly increased, sometimes to double the ordinary crop. This accords fully with the experience of farmers in the Pacific States, where the yield of wheat after alfalfa is always highly satisfactory. As stated, alfalfa yields three cuttings a year. A first cutting from 80 acres this season produced about 135 tons of hay. At the time of the writer's visit (July 9, 1902) the second cutting had just begun.

Mr. Wing uses alfalfa both for hay and for pasture. Many alfalfa growers do not use this crop for pasture on account of the fact that when so used for cattle or sheep there is danger from bloat. In order to avoid this, Mr. Wing suggests that for pasture alfalfa should be

sown with brome grass, and that the pasture be divided into four lots. The number of stock pastured should be small enough so that when turned from one lot to another there should still be abundant feed in the lot vacated, as stock should not go into a new lot in a half-fed condition. At the time they are turned into a new lot the alfalfa should be fairly mature. The only cattle lost from bloat were on immature alfalfa. Only two sheep were lost from bloat this year. Alfalfa grown on an old, richly manured strawberry bed gave rise to bloat oftener than that grown on other land. In this connection, it is perti-

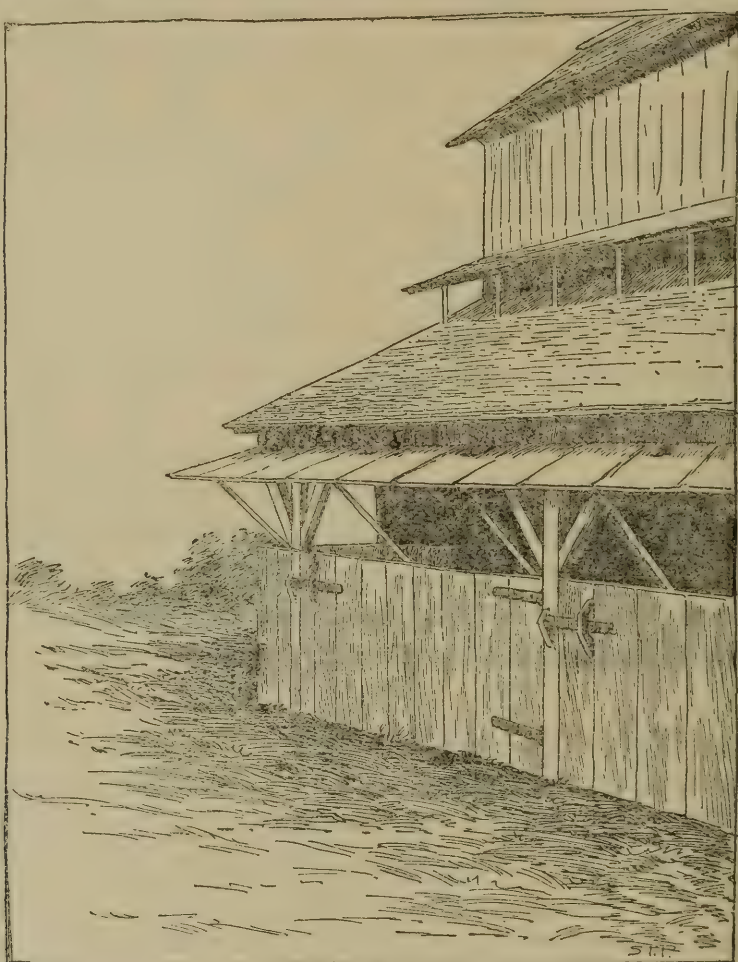


FIG. 36.—Portion of sheep barn of J. E. Wing, Champaign County, Ohio, showing method of ventilating.

nent to remark that on a large cattle farm in Nebraska a few years since, it was noticed that green corn grown on an old feed lot produced so much bloat that its feeding in the green state was abandoned.

CORN.—About 50 acres of corn a year are grown, following either corn or alfalfa. There is a liberal use of manure for this crop. In 1902 the corn on this farm was markedly superior to other corn in that section. The owner does not attempt to grow all the corn he needs, finding it more profitable to grow alfalfa and buy corn. He says he can always depend on finding others who grow corn to sell.

The amount purchased varies from 1,000 to 4,000 bushels a year. This is fed mostly to Western lambs. He replants corn with pumpkins, which he uses as winter feed for breeding ewes.

PASTURE.—Bluegrass is not at its best in this section, though it does fairly well; but Mr. Wing's experience indicates that an acre of alfalfa and brome grass will carry six times as much stock as an acre of bluegrass, and do it better. He is particularly favorable to brome grass in pasture mixtures, though he says it will not stand hard usage as well as bluegrass.

During the season of 1902 a field of 12 acres of alfalfa, brome grass, and bluegrass carried 30 head of steers and 140 sheep from May 1 to June 15. On July 9 this pasture was far from bare, though it still carried a considerable flock of sheep.

SHEEP.—In addition to a herd of about 75 registered Dorsets, 700 to 1,000 Western range lambs are fed. When put on feed these lambs average about 40 to 55 pounds. They are fed four months, during

FIG. 37.—Feeding rack for lambs.

which time their weight increases from 50 to 80 per cent. In exceptional cases 100 per cent increase has been made in this time. The lambs are fed alfalfa hay and corn, but they are never given quite as much corn as they will eat, the amount fed being about 2½ bushels a day to 100 head. A full feed of alfalfa is given, amounting to about 2 pounds per head per day. The lambs are kept in a single large barn, with no partitions, but with ample ventilation (see fig. 36), and "there is a place for every lamb at the first table." The feed is given in racks like that shown in fig. 37. The lambs are let out for half an hour twice a day while the feed is put in the racks, but are kept in the barn at other times to save the manure. "When lambs are on feed give them all the air they can get, and never wake them up when they are asleep." This is a maxim which it has been found advantageous to follow.

MANURE.—Manure is drawn out in winter and spring, usually for corn. What is left is used as a thin top dressing for meadows and pastures.

Conclusion.

The study commenced in this paper will be continued, and publications showing the methods of management pursued on different types of farms in all the principal agricultural sections of the country are under consideration.

The writer is aware that the subject is broad and complex, and that much work must be done before it can be covered in a satisfactory manner. Any suggestions that will tend to increase the value of the series of articles proposed will be thankfully received.

IMPROVEMENT OF COTTON BY SEED SELECTION.

By Herbert J. Webber,
Physiologist in Charge of Plant-Breeding Laboratory.

INTRODUCTION.

In 1902 there were grown in the United States, on 27,114,103 acres of land, 10,417,000 bales of cotton,[a] worth $421,000,000. Cotton is the most extensive export crop grown in the United States at the present time, and the value of the total annual production is exceeded by corn alone. It is the principal crop of ten States, and in large areas of these it is almost the only product grown.

The average yield of cotton in the United States is only about 190 pounds of lint per acre, while on many large tracts carefully cultivated a yield of 500 to 800 pounds per acre is frequently obtained. The market for cotton fabrics is gradually increasing with the increase in population and with the growing demand for such goods in both old and new markets. There would thus seem to be no immediate fear of overproduction of this staple. The United States produces five-sixths of the world's cotton crop at present, and there is within this domain but little opportunity for extending the industry into new regions, although a much larger acreage of cotton could be grown in the old cotton-producing States if necessity demanded it. The tendency, however, seems to be toward diversified farming, rather than further specialization in cotton production. The most important problem now before cotton growers seems to be that of increasing the production on the same acreage rather than extending the acreage itself. Cotton growing in other countries is capable of being considerably extended, but under the present conditions such extension will doubtless be slow and will only slightly affect the industry in this country. The American planter should strive by the application of improved methods and machinery and the use of improved varieties of cotton, yielding more and better staple, to keep well in advance of competitors in foreign countries where cheaper labor is available.

The factor which serves most to place the American grower ahead of his competitors in other cotton-growing countries is his readiness to adopt improved scientific methods and machinery and to bring intelligence to bear in every-day practical farming. The war of

[a] Estimates of production in this paper are those of the Statistician of the Department of Agriculture (Crop Reporter, Vol. IV, No. 8, December, 1902).

competition, however, is a never-ending one, and only by the study and improvement of methods of culture will this country be able to maintain its supremacy in the cotton markets of the world.

The problem of primary importance in the cotton industry at the present time is to increase the production of cotton per acre; in other words, more cotton should be grown on the same land. In traveling through the cotton belt from the Carolinas to Texas, it is surprising how few good fields of cotton are seen, and the writer has talked with many people who have formed the impression that the cotton plant normally grows only to a height of about a foot or a foot and a half.

FACTORS OF SUCCESS.

While the character of the soil is of the greatest importance, still there is great opportunity of improving the industry on all lands, both good and poor. It is safe to estimate that the cotton crop could be doubled on the same acreage as now grown, by proper attention to the two factors so necessary to success, namely, the universal use of good seed and careful methods of tillage and fertilization. It is with the former of these, the production of good seed, that the present article will deal.

The writer has frequently been asked which of these two factors he considers of the greatest importance. It may be stated that both are of primary importance, and that no careful planter can afford to neglect either. The importance of good seed is probably more commonly overlooked than the matter of cultivation. It is too frequently a practice for planters to take any seed they can secure, regardless of whether it is adapted to their soil or climatic conditions, or whether it has been bred up to a high standard of productiveness. From observations in many parts of the cotton belt, the writer believes that fully half the cotton planters use seed taken at random from public gins, about which they know nothing other than that it was produced somewhere in the same vicinity. No planter can afford to be so negligent about any matter so essential to his success. As well might the breeder of fast-trotting horses introduce dray animals into his stables, or the breeder of intelligent hunting dogs introduce ordinary mongrel curs into his kennel. The use of good seed and its production by a regular system of selection is just as important a factor in the production of the crop as that of cultivation. No intelligent method of farm management disregards the production and use of good seed. The day when growers can afford to plant any sort of cotton seed is past. Only seed of a known variety, selected because of its desirable qualities and adaptability to local conditions, should be planted.

One reason why systematic seed selection is not more commonly practiced is that the impression prevails that the methods are costly and difficult of application. Planters connect the simple methods of

selection with the abstruse ideas of hybridization and cross breeding, and think that this work is something apart from ordinary methods of crop production, something for the scientific men only. The fact is, that the methods of selection are easy to understand, simple in application, and inexpensive. Every farmer has a method of cultivation which he pursues with little variation each year. In the same way, every farmer should use a definite method of seed selection and carefully follow it each year. If the object is to breed new and distinct varieties, the work is more difficult, and greater care must be given to all of the details, but even in this case the methods are comparatively simple.

It is the writer's object in this paper to discuss the salient principles on which the production of improved seed rests, and to describe both simple and complex methods of selection. By a careful study of these principles any grower should be able to formulate a method of seed selection with definite objects in view, and growers can not be too strongly urged to adopt some such method and rigidly adhere to its use every year. For many years the general belief has prevailed, though apparently in a large measure traditional, that an occasional change of seed is necessary if good crops are to be regularly secured. Advancing knowledge of the results of breeding are leading now to the opposite belief—that plants must be bred and adapted to soil and climatic conditions. Evidence is accumulating which shows that cotton and corn growers, if they are to obtain the best results, must select their seed in the locality where it is to be regularly grown. This has been forcibly brought out recently in the case of Professor Hays's highly selected wheats. After several years of careful selection at the Minnesota Agricultural Experiment Station a strain of Blue Stem was produced by Professor Hays which yielded from 4 to 5 bushels per acre more than any other of the many varieties tested. Nevertheless, when this wheat was tested at the Iowa and South Dakota experiment stations in comparison with certain standard varieties, its superiority was not so marked. This and many other illustrations emphasize the great advantages to be derived from selecting seed in the locality in which it is to be grown in order to adapt it to the particular soil and climatic conditions.

THE PRIMARY PRINCIPLES OF SELECTION.

THE INDIVIDUAL THE UNIT FOR SELECTION.

In general, plants reproduce their main characters unchanged, and the stability of cultivated plants and natural species depends upon this law of heredity. Plants, however, are not absolutely fixed and stable, but are very unstable and highly variable in minor characters. A careful examination of a field of cotton of any standard variety will show that the plants all differ from each other. Each plant in the field may look in the main like all the other plants, yet each has an

individuality, a facial expression, as it were, which distinguishes it from any other plant. Some plants branch low and some high, some have large bolls and others small bolls, some have long lint and others short lint, etc. It is these variations that furnish the means for improvement by selection. By selecting seed from those plants only which possess the desired feature in the greatest degree or to the greatest extent, that feature may be increased. Experience teaches that seed selected from the most prolific individual will in almost every case give a progeny having a tendency to produce more heavily; if a long staple is desired, as many plants as possible should be examined, and by taking seed from a very few which produce the longest lint the length of lint can be increased. (Pl. XLIII and Pl. XLIV, fig. 1.)

The principle here involved is well and widely known. If the largest individuals of a race are mated together the tendency will be to produce a progeny possibly below the parents in size, but above the mean average size of the race. The improvement of cotton by the continual selection of seed from those individual plants yielding the best or having the longest lint is in accordance with this well-recognized principle.

Aside from these ordinary slight individual variations which are within the limits of the race or species, there occasionally occur large and striking variations which are now known scientifically as "mutations," and which gardeners call "sports." If the selection is made with the view of creating new varieties or races, search should be made for these marked variations. If, however, the aim is simply to secure an improved strain with the same general characters, this can be accomplished by the selection of the slight variations that normally occur. The practical grower will hardly be able ordinarily to distinguish between these two kinds of variation, and the scientific breeder will have to admit that he can not tell where to draw the line between them. Fortunately, in practice it is not necessary to distinguish between these kinds of variation. The two main problems with which the cotton grower is concerned are the production of larger yields and better staple, and in his operations it is safe to select for seed the plants which produce the heaviest and give the best lint, these two ends being kept in view separately or in conjunction in the selection, as seems desirable.

SELECTING FOR ONE PRIMARY FEATURE AT A TIME.

While one can select to improve two features at once, as indicated above, this complicates the process of selection, and it is usually found desirable to select mainly for one object at a time. If attempting to increase the length of lint, it will probably be found that the plants with the longest and finest lint are lacking in productiveness, and that the most productive plants have short lint. Therefore, in selecting primarily to increase the yield, it is best to give attention

mainly to this feature, and simply give sufficient attention to the quality of the lint to see that it is up to the standard of the variety in length, abundance, strength, etc. In selecting to increase the length of lint, this should receive the main attention, care being taken simply to see that the selections do not deteriorate in production to such an extent as to render them unprofitable for culture. If very careful selections are to be carried out, it is necessary to judge each plant by a score card similar to those used in judging stock, each feature considered of importance being assigned a number of points in the score based on its relative importance.

TRANSMITTING POWER OF THE INDIVIDUAL.

What may be termed the transmitting power of the individual is a factor of prime importance in the improvement of any plant by selection. It is not enough to know that individuals have been selected that possess in the highest degree the desired qualities of yield or length of lint. To reap the full benefit of the selection it is necessary to determine whether the plant also possesses the faculty of transmitting this quality to its progeny. The plant's "projected efficiency," as Professor Hays expresses it, must be determined. Some individuals are very prepotent and have the power of transmitting their qualities to all or almost all of their progeny, while other plants lack in prepotency, and the progeny in a large measure fail to show in any marked degree the character for which the parent plant was selected. It is very important, if the greatest possible benefit is to be derived from the selection, that the seed from each individual be preserved separately and planted under the same label, so that all of the progeny from a selected individual may be examined to determine its transmitting power. If the transmitting power is weak and but few plants exhibit the improved character which distinguished the selected mother plant, all of the progeny should be discarded and no further selections made from among them. Further selections, the second year, should be made only from among the progeny of those plants which have the largest number of offspring showing in a high degree the quality for which the mother plant was selected. The variation of different individuals in the strength of their transmitting power renders it necessary to make a number of selections of superior plants in order to insure securing some having strong transmitting power, from which further selections and propagation may be made. It is absolutely necessary that a selected plant should have a high transmitting power, and if it has not it is valueless.

ISOLATION OF SELECT PLANTS AND THEIR PROGENY.

Many plants are normally cross-fertilized, and it is frequently necessary to pay strict attention to this matter at all stages of the work. All varieties and races of corn cross readily, and with this plant the

greatest care is therefore necessary to prevent selections from being pollinated with pollen from inferior individuals or individuals of a different type.

The cotton flower is large and attractive and is much visited by bees and other insects, so that the pollen is carried from one flower to another in considerable abundance; hence in the beginning of the Department's experiments on cotton breeding it was supposed that the danger of cross-fertilization would have to be carefully avoided. However, the flowers are abundantly self-fertile, setting seed normally when covered by paper bags that exclude all insects, and experience has shown that while there is some crossing the large majority of seeds that set are self-fertilized. In several instances varieties have been grown in single rows with other varieties all around them of such a kind that crossing, where it occurred, could be easily detected in the progeny. Plants grown from seed matured under such circumstances show but few crosses, indicating that the majority must have been self-fertilized. Judging from the observations thus far made, it would seem that ordinarily only from 5 to 10 per cent of the seeds are normally cross-fecundated. With cotton, therefore, it is not so important to grow the plants in an isolated location as in the case of corn. Nevertheless, practical experience has shown that when growers procure a small quantity of seed of an improved variety and grow this with other varieties to increase their stock of seed, usually the variety gradually deteriorates. This is probably due in considerable measure to cross-pollination with the ordinary cotton, though also doubtless in part to the fact that the seed received was probably highly selected, and deteriorated when selection was discontinued. While the effect of cross-fertilization is, therefore, not so great as in some plants, it is nevertheless of sufficient importance to justify certain precautions being taken.

After the selections have been made, it is desirable that they be grown together in a patch as far removed from all other cotton as possible, the seed from each select individual being kept together and plainly marked. The pollen of cotton is carried by bees mainly, and therefore it is practically impossible to secure absolute isolation in any cotton country, as this would require a distance of 5 to 10 miles from any other cotton. Practical isolation, however, may be secured by planting the special patch at a distance of a quarter or a half mile from any other cotton, particularly if the patch can be placed so that it is surrounded by woods. Planting in this way will insure that all of the seed produced in the selection patch will be fertilized by pollen from individuals having good mothers as all of the plants in the patch were grown from seed of carefully selected mother plants of the preceding year. In practical seed selection this precaution is all that it is desirable to attempt. If very careful scientific selection experiments are being conducted, it may be found desirable in some cases to be more particular and "rogue" out the patch as rapidly as the plants mature

Imported Stamm, No. 1

First Generation Selection.

Second Generation Selection.

STAMM EGYPTIAN COTTON, SHOWING IMPROVEMENT PRODUCED IN LENGTH AND QUANTITY OF FIBER BY TWO GENERATIONS OF SELECTION. (NATURAL SIZE.)

THE MERIDEN GRAVURE CO.

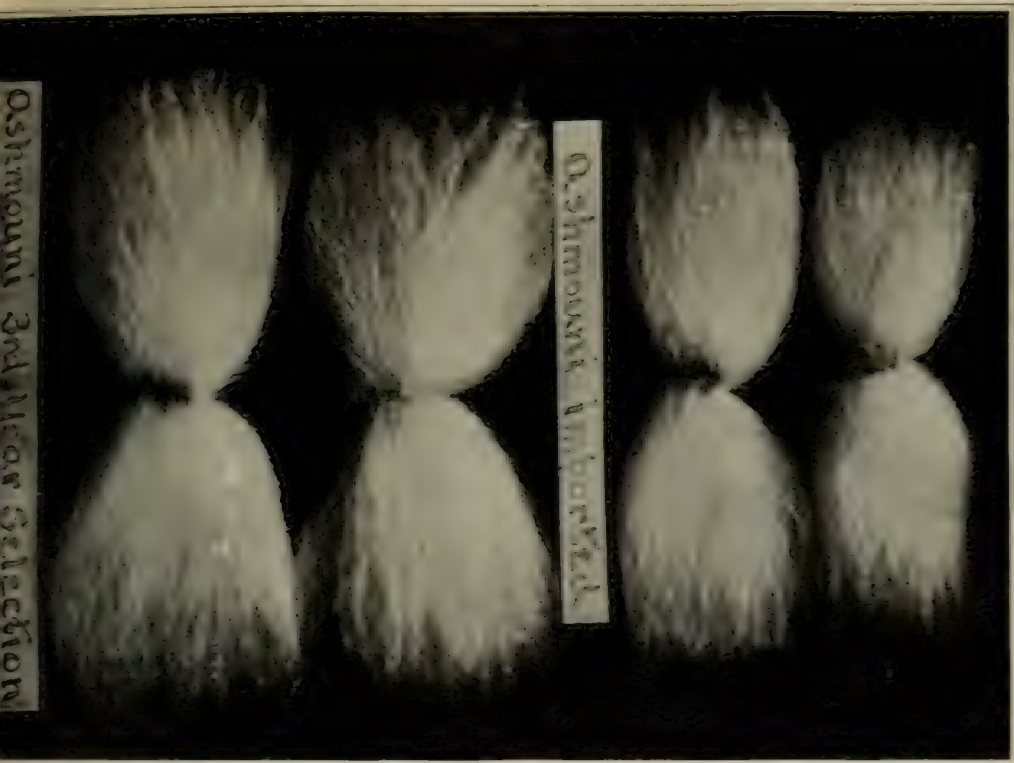


FIG. 1.—ASHMOUNI EGYPTIAN COTTON, SHOWING IMPROVEMENT PRODUCED IN LENGTH AND QUANTITY OF FIBER BY THREE YEARS OF SELECTION.

[Natural size.]

FIG. 2.—FIELD OF HYBRID COTTON AT COLUMBIA, S. C., SHOWING MEN REMOVING ALL BUT THE BEST PLANTS.

FIG. 1.—FIELD OF HYBRID COTTON AT COLUMBIA, S. C. (SAME FIELD SHOWN IN PL. XLIV, FIG. 2), AFTER FIRST SELECTION OR ROGUING.

FIG. 2.—THE SAME FIELD SHOWN IN FIG. 1, AFTER SECOND AND MORE CAREFUL SELECTION OR ROGUING, ONLY THE BEST PLANTS REMAINING.

sufficiently to exhibit their characters. This is particularly true in selecting unstable hybrids to secure fixed types. In the experiments of the Department of Agriculture, where it is desired to take the greatest precaution against the crossing of the best plants with inferior ones, the field from which selections are to be made is carefully examined as soon as the lowest bolls open, and all plants are pulled up which do not show the desired qualities. (Pl. XLIV, fig. 2, and Pl. XLV, fig. 1.) The same field is carefully gone over again in a short time, each plant being examined, and those removed which on second examination do not hold up to the high ideal. (Pl. XLV, fig. 2.) All fields which are being selected to fix a variable hybrid are examined at least four times in this way and weeded out until only a few of the very best individuals remain. This careful process of "roguing" insures that the bolls set in the latter part of the season will be pollinated with pollen from excellent plants of the same type. This process of selection by the roguing out of inferior plants is too tedious and complex to be used except in the case of carefully conducted breeding experiments.

In the selection of seed of Sea Island cotton, which is practiced by all careful growers of this cotton, the seed from the select plants is ordinarily planted in a patch at some distance from, or on one side of, the general field. Even in planting under the latter condition the results obtained have proved very satisfactory, as will be explained later.

CARE OF THE SELECTION FIELD.

All evidence indicates that the seed produced by plants grown on good soil under the best conditions produces in its turn the best and most vigorous seed. It is thus desirable to plant the selection field on good rich soil of the same kind on which the crop is to be generally cultivated. If the general crop is to be grown on a light, sandy soil, it would of course be wrong policy to place the selection field on a rich, heavy loam. The soil should be of the kind used for the general fields, but unexhausted by previous cultivation. It is also desirable that the selection field should be well fertilized and cultivated, as every means should be used to develop the best plants and the best seed.

METHODS OF SELECTION.

A PRACTICAL METHOD OF SEED SELECTION FOR GROWERS.

Objects of the selection.—In general practice, as indicated above, the primary object is to secure increased yield, although it is also important in some cases to increase the earliness of ripening, the length of lint, or the size of the boll. Productiveness is the factor of importance in ordinary seed selection where the grower is not concerned with the production of new varieties, and it is to this that attention should be directed, giving in general only sufficient attention to other factors to keep them up to standard. If, however,

it is desired at the same time to secure improvement in any other direction, the selection should be made with this object in view.

First year's selection.—The first selections should be made in a large field of the variety which it is desired to improve. The field from which the selections are made should have good soil and should be thoroughly cultivated in order to insure a good development of the plants and satisfactory conditions for making selections. Just before the first picking, when some of the lower bolls are well open on all of the plants, the field should be gone over and every plant examined with reference to the productiveness, number and size of bolls, vigor and shape of plant, earliness, etc.

It is desirable to mark more plants than are expected to be used, because in going over and comparing the plants the first time it is ordinarily found difficult to carry the characters desired in mind with sufficient accuracy to enable a careful judgment to be made. Therefore some fifty of the plants should be first marked and numbered, so that these can be more carefully examined a second time and the number reduced possibly one-half or more. The permanent numbers should be placed only on the plants which are finally selected. Before each picking a careful man should go over the field and pick the cotton from each plant in sacks numbered to correspond with the numbers on the plants, in order that the different pickings from the same plant may be kept together.

In the fall, after the close of the picking season, the seed cotton from each individual plant can be more carefully compared and weighed, and any of the plants which are found to have fallen below the standard in production or in any other important feature should be rejected. The remainder should be ginned, care being taken to have the gin thoroughly cleaned out before beginning the process, so that the seed from the selections will not become mixed with ordinary seed. After ginning each individual plant, the seed should be carefully picked up and replaced in the numbered sack, so that all of the seed from the same select individual will be retained by itself.

In describing the method of procedure, it is much clearer to base the explanation on the selection of one superior plant each year, as the process with one plant illustrates clearly what should be done with each of the twenty-five or more which are selected in practice. (See fig. 38.)

Second year's selection.—The seed of the individual plant selected the first year is planted in the spring of the second year and plainly marked, in order to distinguish it from the seed of any other plant selected. Each cotton plant yields from 500 to 2,000 seeds, and therefore 500 or more seedlings will probably be produced. When these plants reach the proper stage of maturity, the entire progeny should be examined to see whether the plant selected the first year has shown strong transmitting power. If a large percentage of the progeny possess the desired qualities in a marked degree, showing

that the transmitting power is fairly strong, several selections of the best plants should be made from among them. If, on the other hand, the transmitting power has been weak, the qualities for which the plant was selected not having been transmitted, the entire progeny should be discarded.

The possibility of having to discard the entire offspring of a select individual is the principal reason for urging that a number of selections be made, instead of only one or two. The specially selected plants of this second generation should be carefully examined with reference to the particular qualities desired, and a single plant finally selected which is superior to all of the others. The seed of this individual should be preserved separately and handled exactly in the same way as the selection made the first year. The seed from the remaining plants produced by the single individual selected the first year should be ginned separately in order to avoid mixing, and retained to plant a seed patch of about 5 acres the third year, in order to obtain sufficient seed of a select strain to plant a general crop the fourth year.

THIRD YEAR'S SELECTION.—The seed from the plant selected the second year is planted by itself in the spring of the third year, care being taken again to mark the progeny of this plant so that it may be distinguished from the progeny of any other plants that may have been selected at the same time. Just before the first picking, all of the progeny should be examined, as in the second generation, to determine the strength of the transmitting power. If the progeny as a whole are found to have inherited the characters of the plant selected the second year, a few of the very-best plants should again be selected and marked as previously. These should be more carefully examined, as in the above instances, and a single superior plant finally selected. The seed of the remaining individuals from the same number as the one selected, which will be about 500 in number, should be retained to plant a seed patch the fourth year, to give sufficient seed to plant a general crop the fifth year. The seed obtained in the third year from the seed patch of 5 acres planted from the progeny of the selection of the first year will this year furnish sufficient seed for the general crop the fourth year.

FOURTH YEAR'S SELECTION.—The seed from the specially selected plant of the third year is planted by itself and marked plainly to distinguish it from other selections, as in the previous year. From the 500 or more seedlings resulting, a particularly fine individual is again selected for further breeding, as in the preceding years, the same care being taken to determine the transmitting power to see that this is up to the standard. The other plants grown from the individual specially selected the third year will this year give sufficient seed to plant a 5-acre seed patch the fifth year. The seed used to plant the general crop of the fourth year is that from the seed patch of the

third year, grown from the unselected plants of the second year, and thus the general crop the fourth year is derived directly from the plant selected the first year, and so on through succeeding generations. The diagram (fig. 38) illustrates the above method of selection.

NECESSITY OF SELECTING MORE THAN ONE PLANT.—It is highly important in practice to select more than one excellent plant, as it not infrequently happens that a very fine plant is found having poor transmitting power, so that the progeny will be even below the general crop of the year preceding. It is impossible in a short article to lay out a general plan which will fit all cases. If the plantation is of moderate size, a sufficient number of individual plants could be selected each year, so that instead of the 5-acre seed patch represented

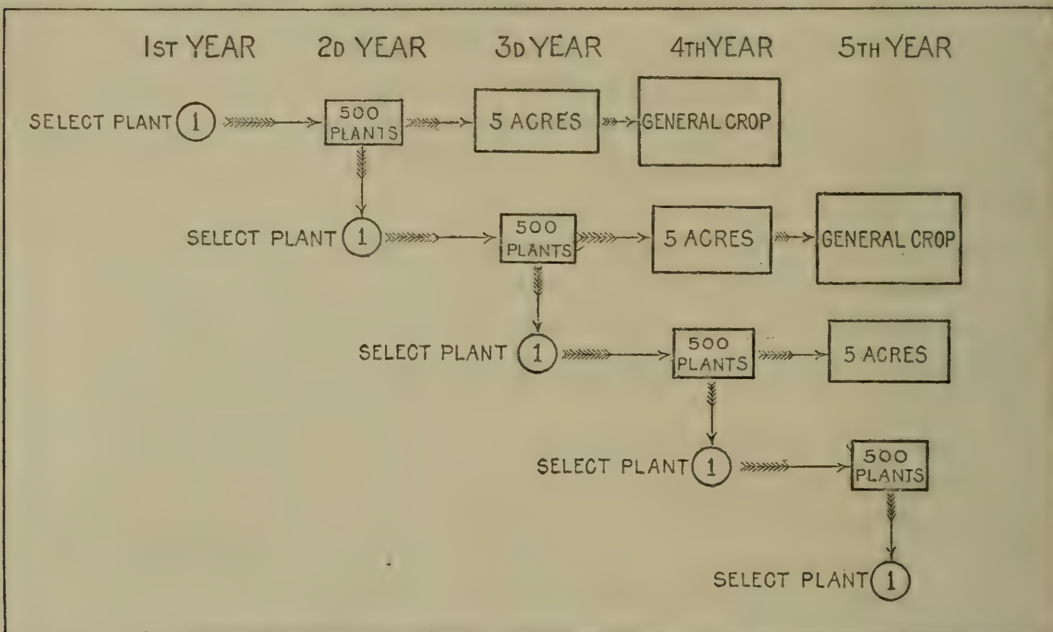


FIG. 38.—Diagram illustrating method of selecting cotton.

in the diagram the entire plantation could be planted. According to this scheme, five plants selected the first year would in the third year plant 25 acres, and if 20 plants were selected the first year the seed patch of the third year, according to the diagram, would plant 100 acres. It is thus within possibility, on a moderate sized plantation, to select enough plants each year to plant the general crop from select seed the third year. The diagram (fig. 38) illustrates the method of selection pursued by planters of Sea Island cotton on James and Edisto islands.

METHODS USED IN SELECTING SEA ISLAND COTTON.

The methods of selection used regularly every year by certain growers of Sea Island cotton are almost exactly the same as those described above, with the exception that more careful attention is given to the quality of the lint, which is of great importance.[a] The

[a] For a careful description of the methods of selection employed by Sea Island cotton planters, see article on the "Improvement of plants by selection," by the writer of this paper, in the Yearbook for 1898, pp. 355-376.

methods used by these planters of Sea Island cotton on the islands off the coast of South Carolina are the most careful and painstaking known to the writer, and under their rigorous selection the fiber has gradually improved in length, fineness, and silkiness, until now it is the best produced anywhere in the world, and is sold at a special price much above that paid for ordinary Sea Island cotton. When Sea Island cotton was first introduced into this country from the West Indies it was a perennial plant, unsuited to the duration of the seasons of the latitude of the sea islands of South Carolina; but through the selection of seed from early maturing individual plants the cotton has been rendered much earlier, until now it is thoroughly adapted to the existing conditions. The fiber has increased in length from about $1\frac{3}{4}$ inches to $2\frac{1}{2}$ inches, and the plants have at the same time been increased in productiveness. The custom of carefully selecting the seed has grown with the industry and may be said to be inseparable from it. It is only by such careful and continuous selection that the staple of these high-bred strains can be kept up to its present superiority, and if for any reason the selection is interrupted, there is a general and rapid decline in quality.

A SHORT METHOD OF SEED SELECTION.

While the method of selection described above is recommended as the best for general purposes, there are some extensive planters who spend but little time on their plantations, and who may not be able to systematically carry out such a plan. For the use of such planters the following short method of selection is suggested: Select careful pickers that remain on the plantation continuously from year to year and train them to recognize the best plants, that is, those most productive, earliest in ripening, and having the largest, best-formed, and most numerous bolls. Each year before the second picking have these select pickers go over the field and pick the cotton from the best plants only. These pickers should be paid by the day and not for the amount picked. Preserve such seed cotton separately, gin it separately on a carefully cleaned gin to avoid mixing, and use the seed to plant the general crop the next year. If sufficient seed is not secured at the second picking, the same pickers can be sent over the field again before the next picking. In general, it is desirable not to use the seed of the first or last picking. It is generally recognized by growers that the seed of the middle pickings give the best results, although in some instances the difference is not very great. This method does not take into consideration the transmitting power of the individual; still, if carried out carefully and intelligent pickers are selected the yield can doubtless be greatly increased. The writer has talked with several growers who have used this method and recommend it as very satisfactory. It is applicable to any variety of cotton and to any locality.

SCIENTIFIC METHODS OF SELECTION USED IN THE ORIGINATION OF NEW RACES AND STRAINS.

The method of selection used by careful breeders in the production of new races and strains does not differ materially from the careful method of practical seed selection described above. The principal difference lies in the greater care which must be used at every stage in the process both in judging the individuals and in keeping careful records in order to determine accurately what advance is being made.

In careful breeding experiments the use of score cards similar to those used by breeders and judges of stock is of the greatest importance. The score card, however, must be a variable one, designed to serve the purpose of the breeder. In experiments in breeding cotton the score card has been found to be indispensable, but it has also been found necessary to use a different form of card for almost every experiment where the object of the breeding is to accomplish a different end. If the object is to secure a black-seeded, long-staple Upland cotton, the greatest importance attaches to the size of boll, yield, length of staple, and percentage of lint, and these characters should be assigned a higher value than other points which are of less importance. If an early, big-bolled, short-staple sort is desired, the qualities of earliness, size of boll, and yield should be especially considered, and should be given the highest number of points in the score.

The following is a score of points used in judging hybrids of Sea Island and Upland cotton, which illustrates the plan followed by the writer, the estimate being made on a basis of 100 points as perfect:

Score of points used in judging Sea Island and Upland cotton.

Size of bolls, 15 points	Very large, 15 points.
	Large, 14 points.
	Medium, 12 points.
	Small, 8 points.
	Very small, 3 points.
Length of lint, 20 points	2 inches, 20 points.
	1⅞ inches, 19 points.
	1¾ inches, 18 points.
	1⅝ inches, 17 points.
	1½ inches, 15 points.
	1⅜ inches, 10 points.
	1¼ inches, 5 points.
Fineness of lint, 10 points	Very fine, 10 points.
	Fine, 8 points.
	Medium, 6 points.
	Coarse, 3 points.
Yield, 20 points	Excellent, 20 points.
	Good, 18 points.
	Medium, 15 points.
	Light medium, 10 points.
	Light, 5 points.
Uniformity in length of lint, 7 points	Excellent, 7 points.
	Good, 6 points.
	Fair, 4 points.
	Poor, 2 points.
Strength of lint, 10 points	Very strong, 10 points.
	Strong, 8 points.
	Medium, 6 points.
	Weak, 3 points.
Per cent of lint, 18 points	33+ per cent, 18 points.
	31–32 per cent, 17 points.
	29–30 per cent, 16 points.
	27–28 per cent, 15 points.
	25–26 per cent, 10 points.
	23–24 per cent, 5 points.

The purpose of the experiment for which this score is used is to secure a variety of cotton for cultivation in upland regions which will have long staple, big bolls, opening well and easy to pick, and black seed. In this series of experiments, however, all plants not having black seed are rejected, so that no provision is made for judging on this point.

On the individual blank record sheets used for notes on the hybrid or selection, below each heading of the blank, two vacant spaces are left. The general notes are written in the upper space and the score record entered in the lower space. The following is a specimen record of this kind:

Specimen individual record sheet.

GENERAL NOTES.

Date planted.	First bolls opened. — Earliness.	Height. — Form of plant.	Disease resistance.	Number of bolls.	BOLLS.		
					Bearing.	Size.	Opening.
March 16, 1901.	August 23.	$5\frac{1}{2}$ feet.	Good.	153	Single.	Very large.	Good.
----------	----------	----------	----------	----------	----------	15	----------

SEED.			LINT.						Yield of seed cotton.	Per cent of lint.	Total score.
Smooth or tufted.	Size by weight.	Covering.	Length.	Color.	Fineness.	Uniformity.	Strength.	Drag.			
Smooth.	0.10 grams.	Good.	$1\frac{3}{8}$ inches.	White.	Fine.	Excellent.	Strong.	Good.	Excellent.	33.5	----------
----------	----------	----------	10	----------	8	7	9	----------	20	18	87

In what may be termed a scientific method of selecting cotton, the plants, which have been carefully compared and marked in the field, should be picked in separate marked bags; the seed cotton should then be taken to a convenient room, very carefully compared with reference to all important points, and accurately graded, the values being entered on a record blank. After the total score of each plant is computed a comparison is readily made. The one having the highest score should, of course, be the best plant, if the judgment in each case has been carefully made, and this plant should be selected and planted the next year, as should also several other of the plants having the next highest scores. The score card allows judgment to be made on a single point at a time, and avoids the confusion which would result from charging the mind with a mass of comparative data which it would otherwise have to retain and weigh. In careful breeding by either selection or hybridization the writer would urge the adoption as early as possible of a score card which will enable comparative judgment to be passed upon one character at a time.

Great care should be used to insure that the selection patch contains

only good plants, true to the ideal type which it is desired to establish. For this reason it is desirable to go over the field when the first blossoms begin to open and weed out such of the plants as are observed to possess undesirable characters of lateness, sterility, or habit of branching. When the first bolls begin to open, the plants should all be carefully examined again, and those showing unfavorable boll, lint, or seed characters pulled up (Pl. XLIV, fig. 2). If the selection patch is in an isolated situation, as it should be, this will insure that all seed that set after the inferior plants are pulled out will have been fertilized with pollen from at least a fairly good plant of the same general type. Thus the eradication of poor plants as rapidly as they can be discovered is of the highest importance where careful breeding experiments are being conducted. In the cotton-breeding experiments that are being conducted by the writer the selection fields are examined from two to four times and the unsatisfactory plants eliminated (Pl. XLV, figs. 1 and 2).

It may be urged by some investigators that in careful experiments, such as are now being considered, the blossoms desired for seed on each good plant should be hand pollinated with pollen from an equally good plant. This was the policy first adopted by the writer; but it requires a great expenditure of time, as many blossoms pollinated will not set bolls. It is believed that results can be obtained in a shorter time by doing the work on a more extensive scale and using the time that would otherwise be spent in hand pollinations in selecting from among larger numbers. As stated above, only a small percentage of the seeds are cross-fertilized, and if the plants developed from such cross-fertilized seeds are widely different from the desired type, they should be discovered and weeded out in the early stages of the selection, before they have had opportunity to influence the other plants to any very great extent.

In careful breeding, notes should be retained of each plant selected each year and a full record made of its transmitting power, as shown by a careful examination of its progeny the following season. This performance record, as it is sometimes called, of a select mother plant is of the highest importance. The select mother plant which has had a strong transmitting power in selections carried on through a series of years is pretty certain to be the progenitor of a valuable race. On the next page is a sample blank such as is used in the writer's experiments in keeping the notes on the progeny of select individuals:

Progeny notes.

Locality where grown.	Date planted.	Number plants grown.	Number plants harvested.	Earliness.	Height. — Form of plant.	Disease resistance.	Size of bolls.	Opening of bolls.
Columbia, S. C.	4/16	1,205	41	Early.	5 feet.	Good.	Large.	Good.
....	....	....	....	....	....	....	14	....

SEED.			LINT.						Yield of seed cotton.	Per cent of lint.	Total score.
Size.	Per cent smooth.	Per cent tufted.	Length.	Color.	Fineness.	Uniformity.	Strength	Drag.			
Medium.	15	85	$1\frac{3}{8}$	White.	Fine.	Fair.	Strong.	Good.	Good.	32	....
....	....	....	10	....	8	4	8	....	18	17	79

While in practical seed-selection experiments, where the object is simply to obtain good and highly productive seed for planting, it is not absolutely necessary to isolate the seed patch, yet in experiments to obtain improved races the select plants of a particular kind should always be grown by themselves in an isolated situation, where they will not be influenced in any way by crossing with other cotton.

SOME IMPROVEMENTS TO BE SOUGHT IN COTTON.

INCREASED YIELD OF FIBER AND SEED.

The possibility of increasing the yield of fiber and seed has been the main feature discussed heretofore in this paper, and need not be referred to here further than to state that numerous instances and experiments show that very marked improvement can be obtained by a few years of selection from the best-yielding plants. The result obtained by the writer in the selection of Egyptian cotton, to be described below, forms a good illustration of increase in yield produced by only three generations of selection. The gradual increase in the yield of Sea Island cotton since its introduction is also in part to be attributed to the careful selection to which it has been subjected, although improved methods of culture have contributed to the same result. In wheat, corn, and many other agricultural crops remarkably increased yields have frequently been secured by careful selection experiments, the exact results of which are in many places on record and can be examined by the student.

INCREASED LENGTH OF STAPLE.

In all varieties of cotton there is considerable variation in the length of the staple produced by different plants, and by the selection of seed from those plants having the longest staple, following the methods described above, the average length can be greatly increased.

Very remarkable results in increased length of staple of Sea Island cotton have been produced by the careful selection to which it has been subjected, as described by the writer in the Yearbook of the Department of Agriculture for 1898.

One of the most striking instances of improvement in both length and abundance of fiber that has come under the writer's observation is a selection of Stamm Egyptian cotton at Columbia, S. C. The few seed of this variety imported had the lint attached as when taken from the boll, and the average length was only about 1¼ inches. (Compare original imported seed, Pl. XLIII). The plants of the first generation in this country were very tall, some of them reaching a height of 8 feet, and very unproductive. Seed from several of the best plants, which were nevertheless inferior, were selected and preserved for planting the second season. The second season the lint from some of the plants was much longer, more abundant, and of better quality than that from plants grown from imported seed. (See Pl. XLIII, seeds marked first generation selection.) The progeny in the second year, grown from the first-year selection, were uniformly earlier, much more productive, and had longer and better lint. The lint on some plants was remarkably abundant and uniform, and in a number of instances reached the length of 1¾ inches. As a result of two years of careful selection in this country the character of the staple had thus been entirely changed and improved.

UNIFORMITY IN LENGTH OF FIBER.

Uniformity in length of fiber is a feature of primary importance, and long-staple cottons especially are capable of much improvement in this regard. This is one of the qualities regularly considered by the Sea Island planters in making their selections. Griffin, one of the best long-staple Upland cottons now grown, is lacking in uniformity, and should be carefully selected to improve this character. While the majority of the fibers range in length between 1½ and 1¾ inches, the fibers near the point of the seed are frequently much shorter than those on the base and middle; and, again, some of the middle fibers are usually very long, frequently reaching a length of from 3 to 3½ inches. This lack of uniformity in length could probably be corrected by a few years of careful selection. In selecting to secure uniformity it is not enough to judge simply by the regularity of all the fibers on the same seed. Seed from different bolls on different parts of the plant must be examined to see that the fiber on the different seeds is of the same length or nearly so. A general tendency to produce fiber of the same length throughout should be bred in the plant. If long-staple cotton is variable in length of fiber there is considerable waste in the process of manufacture, and the value of the staple is impaired. Careful attention must therefore be given to this point in the selection and improvement of all long-staple varieties.

STRENGTH OF FIBER.

Another essential consideration which has great weight in determining the value of cotton is the strength of the fiber, in which many varieties are lacking and to which careful attention should be given. The long-staple Upland cottons, especially those which have thus far been introduced, are very inferior in this quality. The majority, if not all, of these varieties were originated by crossing ordinary Upland cotton with Sea Island, and the almost universal tendency of such hybrids is to produce fiber deficient in strength, although it may be long and silky and approach Sea Island in these respects. Housewives in recent years complain of the weakness of thread, and this may be due in part to the lack of strength of long-staple Upland cotton, which is largely used in the manufacture of thread. In the selection of Sea Island cotton great care is given to the character of strength, and the fiber of this cotton when properly grown is probably as strong as that of any other cotton, unless it be properly-grown Egyptian cotton, which is also exceedingly strong. Sea Island cotton, because of its strength, has been selected after careful tests as producing the strongest and most durable duck cloth for United States mail sacks.

SEASON OF MATURING.

In all varieties there is considerable variability in the season of maturing, and this furnishes the means of securing modifications in this respect. If an early strain is desired, much can be accomplished by selecting seed always from the earliest plants, most of our early varieties having been produced in this way. In the case of the big-boll varieties, such as Truitt, Christopher, Russell, Texas Storm-Proof, etc., the season of maturity is so late that they are not profitable to grow in northern cotton sections. It is desirable that early strains of big-boll sorts be produced.

ADAPTATION TO SOIL AND CLIMATIC CONDITIONS.

Varieties which have been highly selected have by this selection been adapted to the soil and climatic conditions existing where the selection was carried out. If such plants are grown under different conditions they may fail to give equally good results and may require to be bred and reselected in order to adapt them to the new conditions. A pertinent illustration of this principle is furnished by the results that have been obtained in the introduction and breeding of Egyptian cottons in this country. Egyptian cotton is similar in most respects to Sea Island, being distinguished mainly by the character of the fiber, which is much coarser than Sea Island, very crinkly and woolly, and ordinarily of a light-brownish color. The yield in Egypt, as reported by Messrs. Kearney and Means, who have recently visited that country in connection with these experiments, is frequently from 600 to

800 pounds of lint per acre, being much more than is ordinarily secured from our best Upland cottons. When the best imported seeds of Egyptian varieties are planted in this country they almost invariably produce the first year very tall, spindling plants, which set very few bolls. The writer has had this experience with seed of Ashmouni, Abbasi, Mit Afifi, Gordon Pasha, Jannovitch, and Stamm, grown in South Carolina, Georgia, and Florida. The many attempts at growing Egyptian cotton in various parts of the cotton region of the United States have met with such poor success that planters have given it up as impracticable, and the impression prevails generally that the cultivation of Egyptian cotton in this country is a failure.

In 1899 the writer grew a few plants of Ashmouni Egyptian cotton at Columbia, S. C. They were, as above stated, very spreading and open, and set but few bolls the first year. The fiber also showed a tendency to lose its curliness and become whiter than the imported article. The most prolific and earliest plants showing the characteristic Ashmouni lint were selected. Seed of these were planted again in 1900 and selections of the best again made as in 1899. The same process of selection was repeated a third time in 1901. In 1902 the selections were transferred to Hartsville, S. C., where they were planted on similar soil. This season, the fourth in the United States and the third generation of the selection, they gave very promising results. A number of plants not true to type were pulled up and the total production was thereby reduced, yet a yield of 1,303 pounds of seed cotton per acre was obtained which gave 479 pounds of lint per acre. The fiber produced was typical Ashmouni in every respect observable, and proved on comparison to be slightly longer than the best samples of this variety obtained by Mr. T. H. Kearney in Egypt. It is markedly superior to the strain of Ashmouni used in starting the selection, both in quantity of lint on a seed and its length and uniformity (Pl. XLIV, fig. 1). A field of Mit Afifi Egyptian cotton was grown on the same soil about a quarter of a mile distant, planted with seed directly imported. In Egypt this variety ordinarily gives a larger yield than Ashmouni, but at Hartsville, under the same conditions of soil and fertilization, it gave a yield of only 960 pounds of seed cotton and 346 pounds of lint per acre.

By selection in the same way Stamm Egyptian cotton has been very markedly improved in length and quantity of fiber, as described above (Pl. XLIII).

RESISTANCE TO DISEASE.

The apparent possibilities in the development of disease-resistant strains offer a promising field for systematic breeding and selection. It has long been known that in various plants some varieties will resist certain diseases to which other varieties are susceptible. As an illustration, the sour orange is resistant to foot-rot, or mal di gomma, which is caused by a parasitic fungus, and the disease is

universally controlled by budding or grafting the susceptible sweet orange on the resistant sour-orange stock. A similar case of resistance among oranges to a disease caused by a surface-feeding mite has also been discovered by the writer. The Drake Star orange, a late variety of good quality but a light bearer, was found to be almost wholly resistant to attacks of the orange rust-mite, trees of this variety in the center of badly diseased sweet seedling groves producing fancy bright oranges, showing almost no effect of injury.

Experiments recently made by Mr. E. L. Rivers, of James Island, S. C., and Mr. W. A. Orton, of this Department, have shown conclusively that strains of both Sea Island and Upland cottons can be produced by selection which are resistant to the attacks of "wilt" or "black root," a serious disease of cotton which is causing great damage to the industry in South Carolina, Georgia, and Alabama. The method of breeding such immune strains is very simple, and it is easily possible for every planter having the disease on his plantation to breed a resistant strain. In fields of Sea Island or Upland cotton planted on soils badly infected with the wilt fungus almost every plant is killed by the disease before producing any cotton. Usually, however, a plant here and there will be observed which remains unaffected and produces a fair crop. By selecting seed from such immune plants and planting it again on badly infected soil, it has been found that the quality of immunity is usually transmitted to the progeny in a wonderful degree, and by carrying out such selections and planting each year on badly infected fields, Mr. Orton has been able to produce strains of both Upland and Sea Island cotton which are immune to the disease. Several varieties of Egyptian cotton tested in fields infected with the wilt fungus were found by Mr. Orton to possess a high degree of resistance. Jackson Limbless, one of the standard Upland varieties, was also found to be much more resistant to the disease naturally than any other of the ordinary Uplands, but was not so resistant as the Egyptian sorts.[a]

The Iron cowpea was found by Mr. Orton to be resistant to the cowpea wilt, a parasitic fungous disease, and by the writer, in conjunction with Mr. Orton, it was found also to be almost absolutely immune to attacks of the root-knot nematode (*Heterodera radicicola*).[b] Sugar beets resistant to the sugar-beet nematode are also being bred by Wilforth, who has met with considerable success.

In the control of cotton diseases the breeding of immune strains bids fair to be of the greatest importance, as the evidence at hand indicates a considerable difference in the resistance of various individual plants in the case of several maladies, though in no case with

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[a] Bulletin No. 27, Division of Vegetable Pathology and Physiology, U. S. Dept. Agr., "The wilt disease of cotton," by W. A. Orton.

[b] Bulletin No. 17, Bureau of Plant Industry, U. S. Dept. Agr., "Some diseases of the cowpea," by H. J. Webber and W. A. Orton.

cotton other than in the cotton wilt has it been shown that this apparent immunity will be transmitted. In the case of the Mexican boll-weevil, which has overrun Texas and threatens to destroy the whole cotton industry if no check to its spread is found, there is some evidence to indicate that strains of cotton resistant to this insect may ultimately be bred. In examining fields of Upland cotton in different parts of Texas occasional individual plants were observed by the writer in badly infected fields which had set and matured almost all of their bolls, while adjoining plants were almost denuded of their bolls, except a few of the earlier maturing ones which had developed before the weevils had become abundant. Whether such plants possess a degree of resistance or not, and whether this possible resistance will be transmitted to the progeny, remain to be determined. It seems probable that some plants may be discovered and propagated which will be distasteful to the weevils.

In the seasons of 1901 and 1902 the writer, in conjunction with Mr. A. W. Edson, of this Department, grew patches of certain varieties of Egyptian cotton in several parts of Texas. As Egyptian cotton is noted for its freedom from diseases, the effect of the boll weevil on the several varieties was watched with considerable care. A patch of 2 acres of Jannovitch Egyptian, grown at Pierce, Tex., in the season of 1901, was very badly injured by the weevil, giving a yield of only 15 pounds of seed cotton on 2 acres. A small field of Ashmouni cotton at one place in 1902 was also badly injured, showing that this variety was probably as susceptible to attack as any other sort. A field of Mit Afifi cotton of 3 acres, grown at San Antonio, Tex., on the irrigated plantation of Mr. F. F. Collins, gave results which may indicate a degree of immunity, though further trials are necessary before the matter can be satisfactorily settled. The 3 acres of Mit Afifi were grown on land where the cotton crop had been destroyed by weevils the previous year. Near the Mit Afifi, about 200 feet distant, was a small patch of Upland cotton of a little over one-fourth of an acre in extent, a small patch of sugar cane intervening. The weevil did not appear on the patch of Mit Afifi until the middle of October, and when the patch was last examined by the writer the latter part of October the weevils had not yet become abundant. The weevil appeared on the patch of Upland cotton early in the season, and the crop was almost entirely destroyed, only a comparatively few of the early bolls maturing. Throughout the season the weevils were abundant on the Upland patch, while at no time did they become so abundant on the Egyptian cotton. The Egyptian variety gave a yield of 3,200 pounds of seed cotton, or about 1,066 pounds per acre, while the Upland variety gave a yield of 58 pounds of seed cotton, or about 200 pounds per acre. It has been found by investigators and planters that in general early varieties are less affected by the boll weevil than late varieties. When the weevils first appear they are

few in number, but gradually increase as the season advances. Very early varieties may set a large share of their bolls before the weevils become so abundant as to destroy all of the forms and young developing bolls. The Upland cotton was much earlier than the Egyptian and would normally be expected to produce a much larger crop in boll-weevil districts owing to this fact. The striking freedom of the Mit Afifi field from injury by the weevil would indicate that the plants may be in some degree distasteful or resistant to weevil attacks, although this can not be definitely determined without further experiments. Among the Egyptian plants a very few volunteer Upland cotton plants developed, and these, as a whole, remained fairly free from injury by the weevil until late in the season and gave a nearly normal yield. The Egyptian plants were about 2 feet taller than the Upland plants and entirely surrounded them. The fact that these few Upland plants in the field of Egyptian cotton produced fairly well led several persons examining the field to conclude that the absence of weevils in the Egyptian field was entirely accidental. While this may be the case, we are equally justified in assuming that the Egyptian variety, if distasteful and resistant, would in some measure protect from attack the few Upland plants which they surrounded and overshadowed.

If the Mit Afifi Egyptian cotton is in any degree resistant to attacks of the boll weevil, as is suggested by the above experiment, it would be of great importance in the investigation of the boll-weevil problem, for if it possesses any degree of immunity this could probably be greatly increased by a few years of careful selection. In view of the knowledge of the resistance of varieties of other plants to various insect and fungous diseases it would not seem at all impossible or improbable that a variety of cotton might be found that would be resistant to the boll weevil. In experiments of this kind, however, it must be remembered that a variety resistant to a disease under certain conditions, if these conditions are changed may become subject to attack.

Anthracnose, or boll rot, another serious disease produced by a parasitic fungus, is much worse on certain varieties than on others, and individual plants have been observed to vary considerably in degree of susceptibility. Here again there is evidence of an opportunity for the plant breeder to secure material for experiments in the breeding of immune varieties.

STORM RESISTANCE.

In many parts of the country where severe wind or rain storms are common, the cotton is torn and beaten out of the bolls, causing considerable damage. The form of the open bolls in certain varieties prevents the cotton from being blown or beaten out so easily, so that

there are some so-called storm-proof varieties. There is opportunity for considerable improvement in this direction by systematically selecting seed from the plants suffering the least damage from this source.

CONCLUSION.

In this paper the writer has attempted to describe both simple and complex methods of selection, which may be used by cotton planters and breeders, and to point out some of the important improvements and results that can be produced by such means. It is impossible to overestimate the importance of seed selection to the planter. It is one of the fundamental principles of successful cotton growing, and planters are earnestly urged to give the matter careful consideration and adopt a systematic method of seed selection.

The writer has also pointed out a few of the many important improvements which could possibly be obtained by careful breeding, in the hope that some planters may be induced to carry out experiments looking to their accomplishment.

THE COST OF FOOD AS RELATED TO ITS NUTRITIVE VALUE.

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INTRODUCTION.

In very many American families a considerable part of the money spent for food is wasted. In some cases excessive quantities of food are bought, a practice which is conducive not only to overeating and consequent injury to health, but also to extravagant wastefulness; while in other cases the expenditure, though ample, fails to provide adequate nourishment. There is opportunity, therefore, for material improvement of the diet, to the advantage of both health and purse. By a wiser selection of food materials, based upon a knowledge of actual nutritive values, a more satisfactory diet could be secured, which would be better adapted to the physical needs of the individual and at the same time be more economical. What is especially necessary is a consideration of the relation between cost and value for nourishment. In the purchase of other things their value for the purpose for which they are intended is taken into account, as well as their cost. The same principle may be applied advantageously in the purchase of food. When as much attention is given to this as to the other items of household expenditure, it will be found that, with care in its purchase and skill in its preparation, an attractive, palatable, and nutritious diet may be provided at a very reasonable cost.

The value of any food material as a staple article of diet depends chiefly upon the proportion of protein it will furnish for building and repairing the body and the energy it will yield for the production of work and for maintaining body temperature. Fats and carbohydrates are the chief sources of energy in the diet, although protein furnishes some energy also in addition to its other function. From a considerable amount of scientific research, as well as careful study of actual food consumption, it has been found that the amount of protein necessary to keep the body in normal condition depends upon age, sex, etc., and upon the nature and amount of muscular work performed. For the average American workingman, under ordinary conditions, it has been estimated that the amount ranges from 3.5 to 4.5 ounces per day. Men at severe work require more, while for women and children the amount is somewhat smaller, according to age and other conditions. Any considerable excess of protein should be avoided, as this is by far the most expensive nutrient, and aside from being a costly waste, it may result in derangement of the bodily organism.

The amount of fats and carbohydrates in the food may vary more or less extensively with taste so long as, together with the protein, they bring the total energy of the diet up to 3,000 or 3,500 calories per day for the ordinary workingman, although sometimes an over indulgence in fats or sugar may derange the system, and is to be avoided. Besides supplying the needed nutritive material, a diet must fulfill other requirements. Thus, it must be healthful, palatable, and, at least for the majority, reasonably economical. The wholesomeness and attractiveness of our daily food depends in large measure upon variety, which may be secured by selecting varied materials and by different methods of cooking and serving. Theoretically, the body could be nourished by a single food material containing the requisite ingredients, but no one food material contains these in such proportion that it would by itself provide a suitable diet for an adult. For the inhabitants of temperate and warm regions a diet of animal foods alone would ordinarily furnish the body with too much protein, provided the diet supplied sufficient energy, and would be expensive, though such a diet is of necessity adopted in Arctic regions, animal fat there replacing almost entirely the vegetable carbohydrates produced by the abundant plant life of warmer regions. A strictly vegetable diet would be cheaper, but would almost certainly be quite bulky, and unless there were plenty of nitrogenous material, such as is furnished by beans, peas, etc., would perhaps be deficient in protein, while loading the body with excessive amounts of carbohydrates. In tropical countries there is, indeed, among many native races a marked tendency toward a very liberal or almost exclusive use of vegetable foods, possibly due in part to the fact that animal foods spoil so quickly in a warm, moist atmosphere; but experience and experiment alike have shown that for the majority of persons in health, at least in temperate regions, a simple mixed diet is most reasonable and satisfactory. Too simple and unvaried a diet soon becomes monotonous, and may become injurious, because among people who have the benefits of modern comfort and culture the palate revolts against it, digestion and assimilation may be interfered with, and the body may fail to secure the required nourishment as readily and as easily as it should. One other feature of a varied diet is also worthy of consideration. An attractive diet, which is more easily provided where there is variety, is pleasing to the æsthetic sense, which in a way has an indirect effect upon nutrition. The sense of comfort and satisfaction produced by the appearance of good food well cooked and tastefully served is of indisputable value. Fortunately, such satisfaction may be secured without very largely increasing the cost of the diet. It should be well understood, however, that indulgence in luxuries sometimes simply pleases the palate without properly nourishing the body.

The selection of foods which will contribute to the needed variety

in the daily fare will of necessity be governed by the available food supply and market facilities. The choice of foods should also be influenced by their cost, not alone the price paid per pound, but the cost in proportion to the nutritive material furnished, due regard being paid to palatability and the dictates of individual taste. A knowledge of the relative nutritive value of foods, the cost of the various classes of food materials, and the ways in which they may be best combined is of the utmost importance where economy must be practiced, and is worth the attention of all.

VALUE OF FOODS IN PROPORTION TO THEIR COST.

One simple manner in which the economy of different food materials may be illustrated is by a comparison of the amounts of protein and energy obtainable in them for a given sum at market prices. Such a comparison is given in the table following. It is of course impossible to select figures which shall represent the market price of the various materials in all sections of the country, or in the same section at all seasons. The prices here assumed are those which were found current in a number of New England cities at times of normal market values, and probably represent more nearly those in the Eastern part of the country than in the Central, Southern, and Western sections. The variations in the different regions, however, would probably affect the prices of all the materials in about the same proportions, so that the general relation of cheaper to dearer food materials would be practically as here given.

Comparative values and prices of food materials.

Kind of food.	Price per pound.	10 cents will purchase—	
		Protein.	Energy.
BEEF.	Cents.	Pounds.	Calories.
Tenderloin steak	25	0.064	415
Sirloin steak	20	.081	520
Short steak	20	.081	520
Loin roast	18	.090	580
Rib roast	16	.088	730
First cut round	16	.130	560
Round steak	14	.135	635
Chuck	12	.129	765
Rump	12	.114	920
Shoulder	10	.155	920
Second cut round	8	.205	745
Neck	7	.207	1,100
Brisket	6	.200	1,945
Plate	6	.230	2,150
Flank	6	.284	1,860
Shank	5	.256	1,090
VEAL.			
Cutlets	23	.089	310
Loin and rib	18	.093	385

Kind of food.	Price per pound.	10 cents will purchase—	
		Protein.	Energy.
VEAL—continued.	Cents.	Pounds.	Calories.
Leg	16	0.098	390
Shoulder and breast	12	.180	530
Chuck and neck	12	.133	425
Knuckle or shank	6	.346	985
Flank	6	.424	1,370
MUTTON AND LAMB.			
Loin	18	.076	810
Leg	14	.107	640
Chuck and shoulder	12	.099	1,120
Neck	5	.243	1,970
Flank	5	.276	3,630
PORK.			
Smoked ham	20	.071	840
Bacon	14	.065	1,985
Smoked shoulder	13	.108	1,130
Fresh ham	12	.112	1,120
Fresh shoulder	10	.120	1,480
Ribs and loin	10	.134	1,270
Fat salt pork	10	.019	3,670

Comparative values and prices of food materials—Continued.

Kind of food.	Price per pound.	10 cents will purchase—	
		Protein.	Energy.
POULTRY.	*Cents.*	*Pounds.*	*Calories.*
Turkey	18	0.092	600
Chicken	15	.092	520
FISH.			
Salmon, fresh	35	.040	175
Halibut, smoked	20	.097	475
Cod, salt, boneless	20	.139	275
Halibut, fresh	18	.080	265
Salmon, canned	15	.146	615
Shad	12	.078	315
Bluefish	12	.083	175
Mackerel, fresh	12	.096	305
Cod, fresh	12	.141	280
Mackerel, salt	8	.204	1,290
Cod, salt	9	.211	350
Lobster, canned	35	.052	175
Oysters, "solids"	[a]18	.030	130
Lobster, fresh	16	.037	90
Clams in shell	([b])	.025	70
MISCELLANEOUS.			
Sausage	10	.130	2,125
Lard	9	----------	4,685
DAIRY PRODUCTS, ETC.			
Butter	28	.004	1,300
Eggs (per dozen)	16	.083	400
Cheese	16	.163	1,230
Whole milk	[c]3	.110	1,080
Skimmed milk	[d]1.5	.203	1,130
Cream	[e]15	.034	1,220
Condensed milk	12	.073	1,260
VEGETABLES.			
Canned corn	15	.028	455
Canned peas	12	.030	215
Baked beans, canned	12	.058	500
Canned tomatoes	6	.020	175
Celery	5	.045	350
Dried beans	4	.562	4,010
Split peas	4	.615	4,400
Green beans	3	.136	1,230
Green peas	3	.105	850
String beans	3	.067	600
Onions	3	.047	685
Squash	3	.023	350
Pumpkins	3	.017	200
Cauliflower	2.5	.043	560
Cabbage	2.5	.056	500
Sweet potatoes	2	.060	1,900
Green corn	2	.060	900
VEGETABLES—continued.	*Cents.*	*Pounds.*	*Calories.*
Parsnips	1.5	0.069	1,600
Beets	1.5	.069	1,130
Potatoes	1.5	.120	2,070
Turnips	1	.090	1,250
CEREAL PRODUCTS.			
Crackers	8	.134	2,380
Rice	8	.100	2,040
Wheat breakfast foods[f]	7.5	.161	2,260
Oatmeal[f]	7.5	.222	2,460
Buckwheat	6	.069	2,770
Barley	5	.170	3,300
Hominy	5	.166	3,300
Bread, white	5	.184	2,430
Wheat breakfast food[g]	4	.302	4,250
Oatmeal[g]	4	.418	4,625
Rye flour	3	.227	5,430
Wheat flour	3	.380	5,490
Graham flour	3	.443	5,580
Entire wheat flour	3	.460	5,580
Corn meal	2.5	.368	6,620
SUGARS, STARCHES, ETC.			
Cornstarch	8	----------	2,090
Tapioca	6	----------	2,780
Sugar	6	----------	3,130
Molasses	6	----------	2,580
Olive oil	75	----------	565
FRUITS.			
Figs	16	.027	930
Dates	10	.019	1,095
Prunes	10	.018	1,190
Raisins	10	.023	1,445
Pineapple	10	.004	200
Dried apples	10	.016	1,350
Dried apricots	10	.047	1,290
Canned peaches	8	.009	280
Bananas	7	.011	430
Oranges	7	.011	345
Berries	6	.007	290
Cherries	6	.015	575
Muskmelon	5	.006	180
Cranberries	4	.010	535
Fresh peaches	4	.025	635
Pears	3	.020	980
Grapes	3	.033	1,120
Watermelon	3	.006	200
Apples	1.5	.027	930

[a] 35 cents a quart.
[b] 40 cents a peck.
[c] 6 cents a quart.
[d] 3 cents a quart.
[e] 25 cents a quart.
[f] As put up in packages.
[g] In bulk.

A consideration of the facts brought out by figures such as are here given is interesting and instructive. It shows plainly that the market price is no indication of the economy of different materials. For instance, there is as much total nutriment in a pound of wheat flour as in 3½ quarts, or about 7 pounds, of oysters. To judge of the relative value of different food materials it is necessary to compare them as sources of protein or as sources of energy. And it is also apparent that the pecuniary economy of the different food materials depends upon the actual cost of the building material and energy furnished by them. In the example just cited, the quantity of nutrients in the oysters would cost many times as much as the same quantity in the flour. If a food contains little protein or energy, and is high in price, it is evident that it is really an expensive food; on the other hand, another article may be high in price and yet be actually cheap because it furnishes large amounts of protein and energy. Those foods which supply an abundance of protein or energy, or both, at a reasonable price are of most importance from an economic standpoint. A low-priced article is not necessarily a cheap source of nutrients. Cabbage at 2.5 cents a pound is low in price when judged by its bulk; but 10 cents worth of cabbage furnishes only 0.056 pound of protein, and 500 calories of energy, while 10 cents worth of wheat flour at 3 cents per pound furnishes 0.38 pound of protein and 5,490 calories of energy, and is truly cheap. In the same way it is shown that "the best" food, as popularly understood to mean the highest priced, is not necessarily "the cheapest." Ten cents spent for flour or beans or salt mackerel would buy more material for building up the body and giving it energy for work than could be got from 50 cents to $1 in tenderloin steak or lobster or fresh salmon at the prices quoted in the table.

On the other hand, another fact of particular significance in this connection, but not brought out by the figures given, is that the same article is often sold at different prices in different localities, or in the same locality in different seasons. In a number of investigations of the cost of bakers' bread in various towns and cities it was found that the average price ranged from 3.75 cents to 6 cents per pound, and in one city it was found that the bread containing the largest amount of nutrients was sold at the same price, 4.1 cents per pound, as that containing the least.

The difference in the nutritive value of foods may perhaps be most clearly brought out by a consideration of the different groups into which animal and vegetable foods may be conveniently divided, paying due regard to the wholesomeness, physical condition, flavor, and other characteristics, as well as the composition and relative cost.

ANIMAL FOODS.

Animal foods form a very important part of the diet of the American people. From the results of nearly 200 dietary studies, made with families in widely varying circumstances in different parts of the

country, it has been found that on the average various kinds of animal foods, including meats, fish, poultry, dairy products, etc., comprise about one-fifth of the total amount of food. Judged by bulk and weight, they are more expensive, that is, they cost more, pound for pound, than the vegetable foods, but it can not be said that they are as a whole less economical. They are attractive and appetizing, and gratify the average palate as most vegetable foods are incapable of doing, and, what is of more importance, they satisfy a great demand by supplying a readily available source of both protein and energy. In fact, in the studies mentioned above it was found that they furnished more than six-tenths of the protein and nine-tenths of the fat of the total food consumed.

The different kinds of animal foods, however, differ widely in respect to their economy as sources of protein and energy. What is true of most food materials is particularly true of these, that their market price is not regulated solely, or even very largely, by their value for nourishment. Price depends to a considerable extent upon current demand, in the regulation of which one large factor is agreeableness to the palate and the buyer's fancy.

MEAT.

With regard to the different kinds of meat used, the purchaser's choice is influenced very commonly by the impression that there is some peculiar virtue in the costlier cuts. This is a false notion, however, as an ounce of protein or fat from the tenderloin of beef, for instance, has no more value to the body than the same quantity of either ingredient from the shoulder or round. The chief superiority of the expensive cuts of meat is in the tenderness of the fibers, the ease and attractiveness with which they can be prepared and served, and the flavor imparted by the extractives they contain. Cooking the cheaper cuts in such manner as to render the fiber tender requires more time and skill. When carelessly done it removes much of the extractive matter and lessens the flavor, but with careful cooking and seasoning the less expensive cuts can be made very tender, palatable, and appetizing, while as regards composition they are every bit as nutritious as the costlier ones, and, as illustrated above, the same amount of money spent for them generally furnishes considerable more of both protein and energy than can be obtained in the costlier cuts.

It is to be observed that the cut of meat which costs the least per pound is not in every case the least expensive. The question of refuse, chiefly bone, is one to be considered here. Thus, a leg of mutton or a ham or a shoulder of pork contains much less bone than a rib piece, and beef round contains much less than the shank. A rib roast selling for, say, 13 cents per pound as it lies on the block may contain so much bone that when trimmed the actual meat will cost

22 to 24 cents. The least bony parts are generally the most economical from the standpoint of amounts of nutrients obtained, and frequently the lower-priced cuts are those with the least bone—as for instance, the brisket and plate and round—and hence are pecuniarily the most economical also.

A fat cut of meat contains more actual nutrients than a lean cut of the same kind. The proportion of protein in the two cuts may not differ very much, although there is a wide difference in the proportion of fat. For instance, a lean piece of the cut known as chuck and shoulder would contain about 16 per cent of protein and 7 per cent of fat, while a very fat piece would contain about 13 per cent of protein and 23 per cent of fat. Provided the fat is used, the fatter piece is therefore more economical at the same price, because while supplying almost as much building material it is a very much better source of energy.

In the case of either beef, veal, or mutton, as shown in the figures given in the table, the cheaper cuts are the more economical sources of both protein and energy. The reason why the energy value is high as well as the protein is that these cuts contain larger percentages of fat than are found in the more expensive cuts. The relation of the cheaper to the more expensive cuts, as regards economy, is about the same in all three. In the case of pork the most commonly used cuts, aside from smoked ham, bacon, and salt pork, are about equal in economy as sources of both protein and energy; but the cheapest source of energy alone is fat salt pork, which is one of the most economical sources of energy in animal food. Flank of mutton is about equal to it in this respect, but is greatly superior otherwise, in that while furnishing nearly the same amount of energy for a given sum, it supplies also many times as much protein.

POULTRY.

As compared with some of the less expensive cuts of meat and with cereals and legumes, poultry is in general a relatively dear source of protein and energy. The turkey and chicken included in the comparison above are just about equivalent to short steak and loin roast of beef, which are among the higher priced of the meats. Duck and goose are fatter kinds of poultry, and therefore furnish larger quantities of energy, but they are at the same time much more expensive. The use of poultry in the diet, at least in the North, where poultry is relatively dear, is more for variety than as staple articles. It supplied only about 1 per cent of the total food of the diet of the American families referred to above, and furnished less than 3 per cent of the total protein and a little more than 1 per cent of the total fat.

FISH.

In the larger cities in the coast regions of the country the opportunity for the choice of different kinds of fish is very extended. In

the smaller towns and in the interior, on the other hand, the variety is much more limited. On the whole, fish forms a relatively small part of the diet of American families. In the studies before mentioned the total amount of fish comprised barely 2 per cent of the total amount of food eaten. It furnished nearly 4 per cent of the total protein, but scarcely 1 per cent of the total fat of the diet. The value of fish in the diet is thus rather as a source of protein than as a source of energy. Most fish contain very little fat, although some contain as much as lean meat. Among the leaner varieties are cod, bluefish, flounder, and haddock, while among the fat varieties are shad, halibut, mackerel, salmon, and herring.

There is less range as regards economy between the different kinds of fish than between the different kinds and cuts of meat, but even here there is a wide difference. Mackerel, for instance, is fully as nutritious as salmon, but the fresh fish costs hardly a third as much. Salt mackerel is also about twice as economical as canned salmon. Owing to their large proportion of refuse and water, the actual amount of nutrients in fresh fish is usually much less than in meats, and it is somewhat less economical than the cheaper cuts of meat. Preserved fish usually furnishes more nutriment for the same cost than fresh fish. Thus, salt cod furnishes 50 per cent more nourishment than does fresh cod, and salt mackerel more than twice as much as the fresh fish. But boneless cod at 20 cents a pound furnishes practically the same amount of protein and energy for 10 cents as fresh cod at 8 cents per pound. The higher price of the former, which is paid for the removal of the bones and the shredding of the tissue, therefore does not increase very much the actual cost of the nutrients in the codfish. Canned fish, which in effect is cooked fish, compares favorably in nutritive value and economy with the fresh material. Generally speaking, the amount of refuse is small, since the portions commonly rejected in preparation for the table have been removed before canning.

Shellfish are of value more for variety than for actual nutriment, the latter being very small as compared with that in other food materials. Oysters are the most important of the shellfish, judged by the relative amount consumed. Speaking roughly, a quart of oysters contains on an average about the same total quantity of actual nutritive material as a quart of milk, or three-quarters of a pound of lean beef, or 2 pounds of fresh cod, or a pound of bread. But while the weight of the actual nutriment in the different quantities of food materials named is very nearly the same, the kind is widely different; that of the lean meat or codfish consists mostly of protein; the bread contains considerable protein, but a much larger proportion of starch, with a little fat and other compounds. While oysters resemble milk more nearly than almost any other common food material as regards both the amounts and the relative proportions of nutrients, they differ

widely from milk as regards economy; oysters "solids" cost 18 cents a pound or more, while milk costs not far from 3 cents a pound. Oysters are a delicacy, valuable at times for variety in the diet, but by no means economical as a staple article.

Lobsters, crabs, shrimps, and crawfish contain a fair percentage of nutrients, more noticeable when the composition of the flesh alone is considered. But they are prized rather for their delicate flavor, and, except in certain regions where they are very abundant and the cost is correspondingly low, they must be regarded as delicacies rather than as staple articles of diet.

DAIRY PRODUCTS.

Whole milk of average composition is one of the most economical of animal foods used. At 6 cents a quart, which is a common price, 10 cents expended for it will furnish as much protein and more energy than can be obtained for the same sum in beef rump at 14 cents a pound. It may therefore be used very freely as a means of improving the character of the diet by increasing the quantities of protein and energy at a moderate cost. Skimmed milk is even more economical; it contains practically the same amount of protein as whole milk, but costs not more than half as much a quart. As a source of protein, therefore, skimmed milk is twice as economical as whole milk. On the other hand, the energy of the skimmed milk is practically about one-half that of the whole milk, so that the amount of energy obtainable for 10 cents is practically the same in both. This article is one that is too commonly neglected in the dietary. One way in which it could be advantageously used is in bread making. By mixing the flour with skimmed milk instead of with water the protein content of the bread is increased.

It is doubtful if whole milk sold and delivered at less than 5 cents a quart in Eastern cities will ordinarily be as fresh and nutritious as that bringing 6 cents or over. Milkmen can not generally afford to retail milk at such a price in the larger cities, when proper care is given to the cows, the dairy, and the handling of the milk. Probably much that is sold at such price is old, or has been improperly cared for, if not adulterated. At any rate, the buyer can insist on getting a good milk at 6 cents or more a quart, while he might not be able to do so for milk at less than that. There are few foods which it is more important to have carefully cared for than milk.

Cream and butter are much less economical materials, but the proportions in which they are used, more especially cream, are much smaller. The use of butter on bread is a simple method of supplying an ingredient (fat) in which the ordinary bread is lacking.

At 16 cents a pound, cheese is more economical as a source of protein and energy than any kind of meat at the same price; 10 cents spent for it will obtain more nutrients and energy than for cuts of beef, veal, or mutton at 12 cents a pound.

EGGS.

A dozen eggs, which would weigh about $1\frac{1}{2}$ pounds, would furnish 0.13 pound of protein and 640 calories of energy, that is, nearly as much protein, but only about two-thirds as much energy, as a pound of medium-fat beef shoulder, which would cost 10 cents; while a pound of white bread, at 5 cents, would supply 0.18 pound of protein and 2,400 calories of energy.

The cost of fresh eggs varies widely with seasons and localities. At 15, 20, or even 25 cents a dozen, they are comparatively cheap food, but at "fancy" autumn prices their nutrients are dear. Their usefulness in general cooking and the ease with which they may be prepared make them almost indispensable in the ordinary diet.

Many housekeepers are unwilling to use "case" eggs and insist upon having them fresh from the producer, regardless of cost. There is, however, no reason why refrigerator eggs, if properly cared for, should not be wholesome and satisfactory for cooking purposes, though persons with acute sense of taste maintain that they lack the delicate flavor of new-laid eggs; neither is there anything to show that lime or the water glass in which case eggs are sometimes preserved injures their nutritive value, although it is sometimes believed to affect their flavor.

LARD, SUET, AND OTHER ANIMAL FATS.

The greater part of the fat of the diet is derived from animal sources. In the dietary studies of the American families in all conditions of life previously referred to more than 92 per cent of the fat consumed was of animal origin. A considerable part of it consisted of materials that were practically all fat, such as lard and commercial culinary fats, which are chiefly combinations of lard and vegetable oils; of butter and suet, which contain 80 to 85 per cent of fat; and of fat pork, containing from 50 to 85 per cent of fat. These are, on the whole, quite economical sources of energy, although hardly equal in this respect to some of the cereals.

In general, the fatter the food material, that is, the smaller the quantity of substances other than fat contained, the more concentrated it is as a source of energy. In this respect lard stands first among animal foods, and at popular prices it is practically the most economical animal fat. Beef suet is also economical, as it contains a large proportion of fat, together with some protein, and is usually obtained at a very reasonable price. Butter is somewhat less economical, but is ordinarily regarded as practically indispensable in American homes.

Fat is a valuable constituent of food. It is apparently burned at once to yield bodily heat and energy for muscular work, or, if eaten in excess, is stored in the body as fatty tissue, and serves as a reserve source of fuel. It is the most concentrated fuel constituent of food,

a given weight yielding two and one-quarter times as much energy as the same quantity of either protein or carbohydrates. The quantities of fats and carbohydrates per man per day are often omitted from dietary standards, since the body requirements are met by supplying protein and energy, and theoretically, at least, the relative amount of fat and carbohydrates is immaterial so long as the demands of taste are met and the amount consumed is sufficient, together with the protein, to furnish the energy required by the body. The best proportions of fats and carbohydrates in the diet must depend upon climate, individual preference, available food supply, and other considerations. In the average of 38 dietary studies made in the United States of persons at moderate work, the diet contained 134 grams of fat and 487 grams of carbohydrates, in combination with 102 grams of protein.

VEGETABLE FOODS.

Of the different nutrients of foods, the most abundant in the normal diet are the carbohydrates, comprising the various sugars and starches. Very few animal foods contain any considerable amount of carbohydrates, the most noticeable amounts being found in milk. Of the total amount of carbohydrates in the diet, at least 95 per cent is derived from vegetable foods, practically all of which contain some form of carbohydrates in larger or smaller proportions and more or less available to the body for the production of energy. Vegetable foods are therefore more particularly of importance as sources of energy, although they have been found to furnish nearly 40 per cent of the protein of the average American diet, and, as observed below, a number of them are among the most economical sources of protein.

In other ways in which they have an indirect effect upon nutrition vegetable foods are also especially valuable. Thus, they insure a certain bulkiness in the diet, which is commonly regarded as advantageous in digestion in inciting peristaltic action of the intestines, etc. They also furnish an excellent means for securing considerable variety in the diet, the importance of which has already been pointed out.

In respect to their value and economy as sources of protein and energy, the different classes of vegetable foods differ more widely than do the animal foods, the most as well as the least economical of common food materials being found among them.

CEREALS.

The cereal foods furnish a large proportion of the nutrients in the diet of the American people. In the studies of dietaries previously mentioned cereal products of all kinds comprised almost 22 per cent of the total food and supplied 30 per cent of the total protein, 7 per cent of the total fat, and nearly 55 per cent of the total carbohydrates.

These are on the whole the cheapest and most economical materials consumed, although there are some individual exceptions.

The cereals most commonly used for food are wheat, oats, corn (maize), rice, rye, barley, and buckwheat, the first three being by far the most important in this country. They are all deficient in fat, the largest proportions being found in oats and corn. They contain fair proportions of protein, more particularly the oats and the wheat, but the preponderating ingredient of all cereals is carbohydrate in the form of starch. They are not fitted for the best nutrition when eaten alone, but should be combined with some material furnishing protein and fat.

Most of these cereals are used in the form of either meal or flour. The so-called breakfast foods made of wheat, oats, corn, or rice have lately come into very popular favor, and the number of them is rapidly increasing. They are attractive and palatable, affording a pleasing variety, and because of special treatment in manufacture, often including partial cooking, their preparation for the table is very materially simplified, and so they are economical in so far as they save time and labor. The kinds and quantities of nutrients in the different varieties depend upon the composition of the cereal from which they are made. The differences in nutritive value of similar brands from the same cereal are insignificant. Generally speaking, they are all wholesome and valuable, and when reasonable in price are, most of them, economical sources of nutrients and energy as compared with meats or green vegetables. The extraordinary claims made for many of them, however, are unwarranted, and in some cases preposterous. Their nutritive value depends entirely upon that of the grains from which they are made and is no greater than flour or meal from the same sources. Doubtless the attempts made with some of them to increase the ease with which they may be digested have been to some degree successful, and to the extent to which this is true has their value been enhanced for persons with weak digestion. Fortunately, however, such persons are still in the minority, and the cost of such treatment is simply wasted for consumers in general. For them the market prices of the goods furnish but little measure of their economy. They are hardly justified, however, from the standpoint of economy in paying the higher prices which for some of the brands is equivalent to 15 to 20 cents a pound, when other preparations, which will serve every purpose of the costlier ones, may be had for 6 or 8 cents a pound.

The three grades of wheat flour most commonly used are known as standard patent, entire wheat, and graham flour. The graham flour consists of the whole wheat kernel ground in the form of a meal. It is coarser than the other flours, because of the presence of the bran. It is really wheat meal The entire wheat flour is somewhat similar to the graham, but a considerable portion of the bran has been

removed; consequently the flour is ground a little finer. In the production of standard patent flour all the bran is left out, and in addition the germ is removed, for the reason that it contains much of the oil of the wheat, which is likely to become rancid and spoil the flour; and which acts upon the other constituents of the flour so that in baking the bread is darkened in color.

It happens that the proportion of protein is somewhat larger in both the bran and the germ than in the rest of the wheat kernel. For this reason it is popularly contended that the fine flour is less nutritious than those containing the bran and the germ, and a comparison of the total protein and energy obtained for a given sum in the different grades of flour, as already shown, would seem to indicate that the coarser flours are the more economical. As a matter of fact, however, such is not the case. Careful experiments have proven that if there is any difference it is really in favor of the finer flours, for the reason that they are more digestible; hence the body obtains from them a larger proportion of the nutrients contained. Thus, while the flour containing the bran does have somewhat more protein, it is of less advantage to the body for the reason that it is coarse; the protein is bound up in material so tough that it is not easily reduced to powder, and not readily acted upon by the digestive juices.

It is also maintained that removing the bran leaves out of the flour certain mineral matters, as phosphates, that should be retained; and that therefore the finer flour is less nutritious than it should be. Little is known as yet concerning the metabolism of these materials in the body, but such investigations as have been made seem to indicate that the supply in the ordinary diet is more than sufficient for the demands of the body. If it were necessary to increase the quantity of phosphates, it seems doubtful whether the most desirable way to do it would be to add them to the diet in such indigestible materials as bran.

In some cases, as for instance persons of sedentary habit or occupation, the coarser grades of flour are often of advantage in influencing a healthy activity of the digestive organs, and the fact must not be lost sight of that they are useful in almost all families to give variety to the diet. On the whole, the evidence seems to prove that the actual difference in nutritive value between the three flours is very slight, and any kind of wheat flour is a very useful and very economical food material.

As previously pointed out, the price of bakers' bread is very variable and is quite independent of its nutritive value, so that its economy varies widely even in the same localities. The question whether it is more economical to buy bread than to make it at home depends largely upon the cost of flour, fuel, and labor, and the price at which bread can be bought. The cost of nutrients in flour is scarcely half as much as in bread made from the same flour when the bread is bought from the baker at a fair price. Where the cost of

bakers' bread is high it would probably be cheaper to make the bread for a large family at home, especially if it can be baked when a fire is being used for other purposes, so that no extra fuel is required. Where the amount of bread used is small, the question whether the slight saving in cost is worth the extra trouble is one which the housekeeper must decide for herself.

Wheat breakfast foods are in general quite similar to graham or entire wheat flour in composition, and are in general about equal to them in nutritive value. Their superiority is chiefly in the greater ease with which they may be prepared for the table, and their relative economy as sources of nutrients and energy depends largely upon the saving in labor and cost of preparation.

Oats are sold principally as oatmeal or rolled oats, either in bulk or put up in packages. The cost per pound in the latter form is nearly twice that in the former; hence they are but half as economical. Large quantites of nutrients and energy can be obtained for a small sum in oatmeal or rolled oats in bulk. At 4 cents a pound they will furnish more than twice as much of both protein and energy for 10 cents as a cheap cut of beef, such as brisket, at 6 cents a pound. Oatmeal does not agree with some people, and because of its coarser nature, and unless it is very thoroughly cooked, it may be less completely digested than some other cereal food materials, and in that case would be actually less economical.

Maize or indian corn is used largely as corn meal and as breakfast foods in the form of hominy, samp, etc. Of all cereal foods, corn meal furnishes the largest amount of energy for a given expenditure; it likewise contains considerable protein, although in smaller proportions than wheat flour, and at ordinary prices is a very economical material. It is somewhat less digestible than wheat flour, because of its coarser nature and the presence of bran.

There is in some localities a very erroneous impression that white corn meal is not so nutritious as the yellow meal. As a matter of fact, the color of the meal is due simply to the color of the corn from which it is ground, and when the two varieties are grown under similar conditions the yellow and the white corn are almost identical in composition and of equal food value.

The breakfast foods prepared from corn are also, at reasonable prices, economical materials. They are palatable and attractive and easily prepared, but there is little other reason for paying more for them than for corn meal.

Rice forms an important part of the food of at least a third of the human race. It is used considerably in this country and is cultivated to some extent here, but not sufficiently to meet the demand for it. It is a very desirable food and easily digested, but as a source of either protein or energy it is not as economical as any of the cereals previously discussed. Its principal ingredient is starch, being notably

deficient in protein as compared with wheat or oats. The statements so popular regarding the exclusive use of rice in some Oriental countries are found on more careful observation to be unwarranted by fact. The rice is usually supplemented by some material richer in protein, very commonly pulses and other legumes.

Barley is not used very extensively as food in this country, its principal use being in soups and broths. Buckwheat flour and rye flour are somewhat similar to corn meal as sources of protein and energy, but are more expensive and hence less economical. The latter of the two is used the more extensively, but not nearly so much as the other grains discussed.

SUGARS, STARCHES, ETC.

While all food materials may serve as sources of fuel to the body, there are certain ones, such as sugars and starches, with which this is the chiefest function. Cane sugar, maple sugar, molasses, sirup, and honey, cornstarch, sago, tapioca, and the like consist either entirely of carbohydrates or of carbohydrates with more or less water.

These materials, especially sugar, serve to flavor food and render it palatable. They are much used alone and in the preparation of made dishes. The use of sugars in large quantities, however, is of doubtful advantage, if not at times actually deleterious, since with some people they tend to derange the digestive system. But the chief objection to excess in the use of sugars, etc., is that they increase the energy value of the diet out of proportion to the protein.

Pure sugar is a cheap and economical source of energy, and when taken in small quantities is supposed by many physiologists to yield strength to the body more quickly than any other solid food; for this reason it is much used by persons under extreme muscular exertion. Large quantities, however, taken either alone or in fancy sweets, load the system with unnecessary material and make other foods seem tasteless and unpalatable. Sugar should, therefore, be used in moderation, especially by persons inclined to corpulency.

The various carbohydrate materials differ widely as regards their economy, a thousand calories of energy costing considerably more in the form of maple sirup or honey than in the form of ordinary sugar. The maple sirup and honey are prized for their delicate flavor even more than for their sweetening power, and for this reason will find a ready sale at a higher price than sugar.

Starch, whether present in combination with other materials, as in the cereal grains, or separated, as in cornstarch, tapioca, arrowroot, and sago, is, like sugar, an important source of energy. The starches differ considerably as regards their cost per pound, but are probably of nearly equal value as sources of energy. The higher cost of arrowroot, tapioca, and some other starches is due to some fancied

superiority in mechanical conditions or flavor or other similar cause. In general, it may be said that separated starches, like cornstarch and tapioca, are at present prices somewhat more costly sources of energy than sugar. In potatoes and cereal grains they are fairly inexpensive.

VEGETABLE OILS AND FATS.

Since earliest times olive oil has been an article of diet. Other oils used as food are obtained from cotton seed, sunflower seed, peanuts, and other oil-bearing seeds. Solid fats, more or less used, are obtained from cocoa beans and from the cocoanut. Olive oil is probably the most prized of vegetable fats on account of its peculiar and delicate flavor, but all these materials are considered wholesome, and like the common culinary fats of animal origin, are useful as sources of energy. For this purpose they all have much the same nutritive value, but some cost more than others on account of more attractive appearance, purity, or flavor.

Pure olive oil which has been made with care is no more nutritious than a wholesome vegetable oil of inferior flavor, but it is unquestionably more satisfactory to the discriminating palate.

In general, it may be said that fats and oils are more concentrated foods than sugar and starches, since they yield 2.25 times as much energy per pound, as previously noted (p. 397). The best proportion of fats and carbohydrates in the diet must be governed by climate, individual peculiarities, and similar considerations.

VEGETABLES, FRUITS, AND NUTS.

It is perhaps in the vegetables and fruits that the greatest variety in the diet is obtained; at the same time these same classes of food materials for the most part yield the smallest return in nutrients and energy for the money expended, and among them may be found many excellent examples of the fact that the price of food is no indication of its nutritive value. Cucumbers, for instance, are of no more value to the body in February than in July, yet the price is many times as great.

With the exception of dried legumes, such as beans and peas, the proportion of protein in vegetables is small, and in many of them it is doubtful if much more than half of that shown by analysis to be present is in forms available to the body for use. The principal nutriment contained is carbohydrate, but this in many of the vegetables and fruits, especially in the green state, is in small proportion as compared with that in the cereals. It is found in largest proportion in such vegetables as potatoes, sweet potatoes, parsnips, and beets.

While vegetables are more or less of a necessity in order to provide bulk, to supply the body with mineral salts, and to add to the palatability and attractiveness of the diet, these purposes can probably

be served as well by a small as by a great variety. It is evident, therefore, that where strict economy must be practiced it is not necessary to include a large variety of vegetables in the diet, especially green vegetables early in their season when the prices are high. In such cases care should also be taken to provide as much as possible those which actually do furnish the most nourishment. In the course of some dietary studies made in one of the poorer districts of Chicago it was found that a woman, whose husband was out of work and whose family was living on a few cents a day, bought hothouse lettuce while she had to do without nutritious food. Lettuce is a very palatable vegetable, though it furnishes practically no nutritive material, and no one can object to the use of it or any other wholesome article when the purse allows; but it is pitifully bad economy, in cases like the above, to buy materials which simply please the palate while the body goes without proper nourishment.

When fresh food is available, canned vegetables, even at favorable prices, are rather expensive sources of both protein and energy. In certain cases, however, these food products may be regarded principally as appetizers, rendering the diet more palatable and acceptable, and thus doubtless increasing the consumption of other food of less marked flavor, but of much greater economy. Under some circumstances, when used in moderation in this way, these materials need not be necessarily uneconomical.

Of all the vegetable foods, dried beans, peas, lentils, cowpeas, and other legumes furnish the largest amount of protein. They also contain considerable amounts of carbohydrates and some fat. Dried beans and peas are usually sold at such a comparatively low price that, considered as sources of both protein and energy, they are undoubtedly among the most economical staple articles of diet. They are superior to any other vegetable food, even the cereals, as sources of protein, and they also compare very favorably with most kinds of meat in this respect, and are much more economical than the costlier kinds. It must be remembered, however, that digestibility is to be considered, and dried legumes are inferior to meats in this respect. The immature green peas, beans, etc., surpass other succulent vegetables in protein content, and are nearly equal to the roots and tubers.

As sources of protein most fresh fruits are relatively expensive, although some of them compare very favorably with different kinds of animal foods as economical sources of energy. It must not be forgotten, however, that both fresh fruits and those dried or otherwise preserved are valuable for other reasons than the nutrients which they furnish. They contain acids and other materials which are believed to have a beneficial effect upon the system, and doubtless very often stimulate the appetite for other food. They also add very materially to the attractiveness of the diet.

Nuts are used in the ordinary household more as luxuries or

accessories than as staple articles of diet. Like the cereals and dried legumes, they are concentrated foods, that is, they contain a fairly low proportion of water and a correspondingly high proportion of nutritive material in proportion to their bulk, and, generally speaking, such foods are more economical than the succulent foods. All nuts contain a fairly large proportion of protein, and some of them large proportions of fat also. When they are reasonable in cost they are fairly economical articles of diet, and should be considered as available sources of protein and energy, and not altogether as luxuries, as is generally the case.

BEVERAGES, CONDIMENTS, ETC.

Tea and coffee are luxuries having in themselves practically no nutritive value. They are consumed because they please the palate, and have refreshing and stimulating properties. These substances used in excess have a harmful effect upon some persons. The diet of tea and bread common among the poorer classes in some localities is not only very faulty, but the money spent for tea could be more wisely spent for some material containing actual nourishment.

The coffee substitutes made from roasted cereals do not have the stimulating properties of coffee. The high nutritive value commonly claimed for them, however, does not exist. When prepared as commonly directed, a liter (about a quart) of the infusion would contain only enough extracted material to furnish some 40 to 50 calories of energy.

Although cocoa and chocolate contain large quantities of nutrients and energy, the decoctions made from them are not very nutritious in proportion to their bulk, because they are so very dilute. When prepared with milk and sugar the nutritive value is largely increased because of the nutrients thus added. As sources of nutrients and energy, cocoa and chocolate are not economical, but they afford pleasing variety and attractiveness.

Little is definitely known regarding the real value of flavoring matters and condiments. Few of them furnish any considerable amount of actual nourishment, hence whatever value they have must be due to the variety they afford, to their agreeable flavor, and possibly to the stimulating effect upon the glands of the digestive tract. Experience shows that in countries where the climate is hot and vital processes are languid, such things as pepper, chili, curry, etc., are favorite adjuncts to the diet. Ordinarily, however, pickles, spices, and other condiments do little more than gratify the palate. Too frequent and abundant use of them adds unnecessarily to the expense of the diet.

The amount of money sometimes spent for certain kinds of flavoring materials is out of all proportion to their value. For instance, in some localities soup greens are very popular. These contain practically no

nutriment, and as flavoring materials are expensive at the price usually paid for them, for the soups in which they are used could be palatably seasoned with condiments which cost less. Celery for flavoring, unless the tops, or other portions not suited for the table, are used, affords another illustration. Either celery seed or celery salt would probably be more economical than the fresh vegetable as flavoring material. It is true that the sum involved is not large, but where strict economy is necessary the matter is of importance. It also affords an illustration of the fact that the practice which is easiest may not be the most economical.

CONCLUSIONS.

Different foods furnish nutriment in different proportions and at different costs to the consumer. The best foods are not necessarily the costliest nor the cheapest; they are those which are best fitted to the needs of the body, and must be found by experience. The cheapest foods are those which furnish the largest nutritive returns for the money expended. In this respect foods may be classed as cheap, medium, and expensive. But some foods are expensive sources of protein and cheap sources of energy, and vice versa. It is therefore convenient to classify foods according to their relative value as sources of protein and as sources of energy. According to such a classification the common food materials may be grouped as follows:

FOODS GROUPED ACCORDING TO THEIR VALUE AS SOURCES OF PROTEIN.

CHEAP.—Furnishing more than 0.15 pound of protein for 10 cents at ordinary prices: Dried beans and peas; cereal products, such as wheat flours, wheat breakfast foods, oatmeal, corn meal, hominy, rye flour, and bread; cheaper cuts of meat, not exceeding 10 or 12 cents a pound, such as veal flank and knuckle, beef flank, shank, plate, neck, second cut round, and brisket; mutton flank and neck; cheese; salt mackerel; skimmed milk.

MEDIUM.—Furnishing 0.075 to 0.150 pound protein for 10 cents at ordinary prices: Preserved fish, such as salmon, cod, and halibut; green beans and peas; cuts of leaner meat not exceeding 20 cents a pound, such as beef shoulder, round, rump, chuck, rib, and loin; veal chuck, rib, and loin; mutton chuck, rib, loin, and leg; pork rib and loin, shoulder, and ham; fresh fish; eggs (not exceeding 24 cents a dozen); chicken and turkey; whole milk; rice.

EXPENSIVE.—Furnishing less than 0.075 pound protein for 10 cents at ordinary prices: Condensed milk; meats at more than 20 cents a pound; fat meats, such as bacon and salt pork; shellfish, as clams. oysters, and lobsters; cream; fresh and dried vegetables; fresh and dried fruits; fats, as butter and lard; starches, as tapioca, sago, and cornstarch; sugars, canned vegetables, and fruits.

FOODS GROUPED ACCORDING TO THEIR VALUE AS A SOURCE OF ENERGY OR FUEL.

CHEAP.—Furnishing more than 1,900 calories energy for 10 cents at ordinary prices: All cereal products; sugars, starches, etc.; lard; dried beans and peas; cheap fat cuts of meat, such as beef, plate and brisket, and mutton neck, fat salt pork and bacon; potatoes and sweet potatoes.

MEDIUM.—Furnishing 800 to 1,900 calories energy for 10 cents at ordinary prices: Such cuts of meat as beef flank, neck, shank, and shoulder, veal flank and knuckle, mutton chuck, rib, and loin, and the cuts of pork with the exception of bacon and fat salt pork; such vegetables as green peas and beans, parsnips, beets, and turnips; dried fruits; butter, cream, condensed milk, whole and skimmed milk; salt mackerel; a few fruits, such as apples, pears, and grapes.

EXPENSIVE.—Furnishing less than 800 calories energy for 10 cents at ordinary prices: The leaner and the more expensive cuts of meat, such as beef chuck, rib, round, and loin, mutton leg, and most cuts of veal; chicken and turkey; eggs, when costing over 25 cents a dozen; fresh and preserved fish and shellfish; green vegetables, such as cabbage, lettuce, cucumbers, tomatoes, celery, greens, etc.; fresh fruits, except those enumerated above; canned vegetables and fruits.

A classification like the above affords an excellent illustration of the way in which practical application may be made of a knowledge of the relation between cost and actual nutritive value of food.

For the sake of variety, it is justifiable to include in the diet occasionally some delicacy which is expensive and simply pleases the palate, while furnishing but little nutriment. With a clear knowledge of the amounts of nutrients to be obtained for a given sum in the various materials the purchaser can determine how large an expenditure can be afforded in a given line; and when an expensive but innutritious article is included in the diet the necessary protein and energy may still be provided and the total expenditure kept within a certain sum by combining with it those materials which furnish large amounts of nutrients at a small cost.

While in a general way the different classes of food materials may be discussed according to their economy as based upon nutritive value and cost, it is not the purpose of such discussion to give definite rules that may be applied in all cases. This would be impossible. Individual requirements and individual peculiarities will always affect the choice of foods. The object of any discussion of food values must be rather to give the facts as they have been learned by experience and experiment, and to show their relation to the problem of proper nutrition. Each family must determine how the facts can be applied in its own particular case.

GRAPE, RAISIN, AND WINE PRODUCTION IN THE UNITED STATES.

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The Grape-Growing Industry.

EARLY HISTORY.

When America was discovered the wild vine was so prominent a feature of the vegetation that the name Vineland was more than once applied to the country. Considerable wine was produced from a native grape in Florida as early as 1564. The London Company planted vineyards in Virginia prior to 1620, and many succeeding attempts at grape growing were made by William Penn and by German and Swiss settlers. Of more recent attempts to cultivate the vine on the Atlantic coast, the first were confined to European varieties, and were not successful. The Mission Fathers in California were the first to successfully grow the European grape in the United States. They grew grapes at the missions for their own use only, the work being principally done by Indians. They had but one variety, which is still largely grown, and is known by the name of Mission. It is first heard of as introduced into Mexico in 1520. Chronologically, it was brought to the California missions, as follows: San Diego, 1769; San Gabriel, 1771; Los Angeles, 1781; and Santa Barbara, 1786. The Mission vine planted at Montecito, Cal., in 1795, was exhibited at the Centennial Exposition in Philadelphia. It was 18 inches in diameter, and in one season had produced over 5 tons of grapes. From the missions, the viticultural pioneers received their inspiration as well as their start of cuttings

NEW ERA IN GRAPE GROWING.

Mr. John Adlum made the first really successful efforts at grape growing on the Atlantic coast. In 1820 he planted a vineyard near Georgetown, D. C., consisting mostly of native vines. His introduction of the Catawba variety into general cultivation was the beginning of a "new era in grape history." In a letter written by him to Nicholas Longworth in 1825, he says that "in bringing this grape into public notice I have rendered my country a greater service than I

would have done had I paid the National debt." Since its first introduction, grape culture has gradually increased, and interest in it has become general throughout the land. Such rapid progress was made that in 1830 Mr. W. R. Prince, in his treatise on the vine, enumerates 88 varieties of American vines. To-day there are at least 1,000.

Mr. Ephraim Wales Bull is deserving of lasting gratitude for raising from seed and giving to the world the Concord grape, destined to become the most widely known, most generally planted, and, for all purposes, the best American grape yet introduced. Only a few miles from Concord, Mass., stands Bull's cottage, in the dooryard of which still grows the first Concord vine, from which stock the unnumbered millions of vines of this variety came. On one side hangs a square oak board on which these words are artistically burned:

> I looked about to see what I could find among our wildings. The next thing to do was to find the best and earliest grape for seed. This I found in an accidental seedling at the foot of the hill. The crop was abundant, ripe in August, and of very good quality for a wild grape. I sowed the seed in autumn of 1843; among them the Concord was the only one worth saving.—EPHRAIM WALES BULL.

The Concord is included in nearly every collection where American vines are planted. To illustrate what a boon it has proved to be, it need only be stated that the Chautauqua grape belt, on Lake Erie, in 1900, produced 192 million pounds of grapes, at least nine-tenths of which were Concords. Mr. George Husmann, the father of the writer, in 1865, said: "One-third acre of Concord, planted five years ago, has produced me, in fruit, wine, layers, and plants, the round sum of $10,000 during that time."

In the United States there are two distinct grape-producing sections, one east of the Rocky Mountains, where the American varieties are largely and profitably grown, the other in California, where the Vinifera varieties have found a congenial home. These sections differ not only in their products, soils, and climate, but also in their methods of pruning, culture, gathering, working, and marketing of crops, so that only those familiar with both sections are able to make a just comparison.

BEGINNING OF A COMMERCIAL INDUSTRY.

The decade closing the first half of the last century witnessed the birth of commercial grape culture in the United States, leading up to the making of choice wines from American grapes. The manufacture of sparkling wine and unfermented grape juice has been developed in the Eastern States, while the Pacific coast has entered into direct competition with the choicest European wines, and has captured the raisin market of this country. The efforts of Longworth and others at Cincinnati in grape growing and wine making were followed by many in other States, especially in New York, Missouri, Virginia, Indiana, Illinois, Kentucky, Pennsylvania, the Carolinas, and

Michigan. In California, where the Mission had so far been the only variety cultivated, introductions of the choicest European varieties soon followed. In 1850 the country produced almost 250,000 gallons of wine. In 1860 the product had reached over 1½ million gallons, and all the States and Territories except four were growing grapes. The census of 1860 shows California, New York, and Ohio as the three leading wine-producing States. From 1860 to 1875 rapid progress was made. In 1870 Missouri produced more than any other State, except California. With this exception, California, New York, and Ohio have taken the lead. In 1900 their combined output was 22,404,085 gallons of wine out of a total of 23,425,567 gallons for the whole country. From 1875 on, quite a decline occurred, especially in Missouri, owing to black-rot and other diseases.

To sum up, American wines and brandies have taken high honors at all important expositions, including that at Paris in 1900, and they are rapidly finding their way into all the principal markets of the world.

GRAPE CULTURE.

SOIL, LOCATION, AND SITE.

Soil, location, and site will differ greatly with the object in view. Some varieties of grapes may be grown on almost any soil. Usually those lands are selected that can be prepared and planted with the least labor, that are the easiest to cultivate, and which produce the largest crops. Quality and quantity, however, in most cases do not go hand in hand. The best soils are a gently sloping, well-drained calcareous loam, of sufficient depth, with porous subsoil; gravel or small stones in a soil are not a detriment. Some prefer a sandy soil with a gravelly substratum. The place should have a good water supply, be of easy access to market, and free from late spring frosts. The cellar or packing house should be centrally located on the place, and if possible so that the grapes can be hauled down grade, or at least on a level. For this purpose a hillside into which a cellar can be excavated, facing so that each story can be easily approached by wagon, is to be preferred.

PREPARING THE SOIL.

The soil should be well prepared. It should be cleared of large stones, stumps, and other obstructions, and not only be thoroughly and deeply plowed, but subsoiled as well. If it be virgin soil it will be of benefit to raise a crop of grain on it the season previous to planting, as this gives a better opportunity to put it in good shape. Any wet spots should be carefully drained. After being plowed and subsoiled it should be thoroughly harrowed and the clods crushed with drag or roller.

MANURES AND FERTILIZERS.

On partially exhausted or poor soils such manures and fertilizers should be applied as will give them those substances in which they are deficient. Broadly speaking, if the soil lacks in fruit-producing qualities, potash is needed; if more wood growth is desired, nitrogenous fertilizers should be supplied.

CHOICE OF VARIETIES TO PLANT.

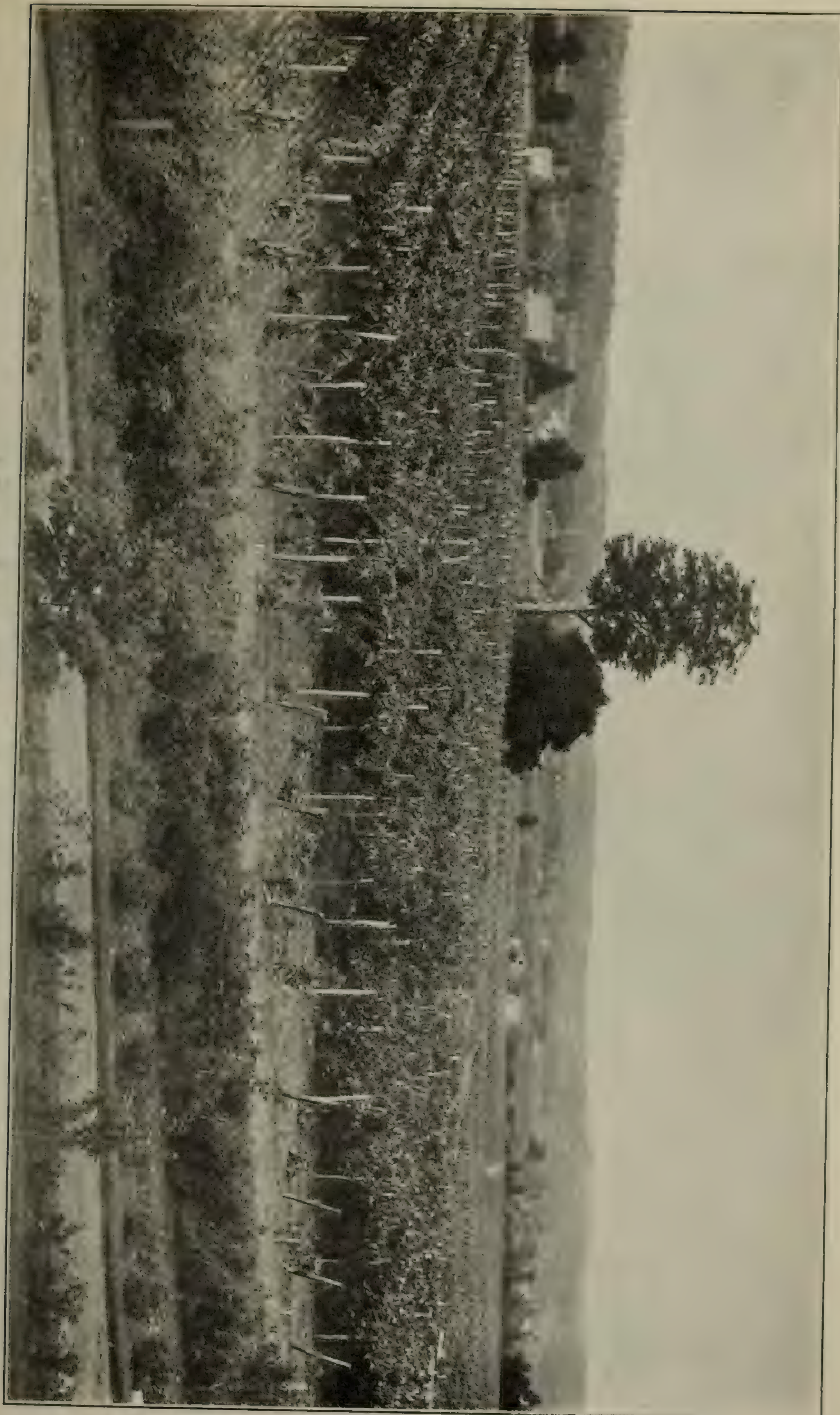
As to varieties of grapes to plant, each locality must in a measure determine this for itself, grape growing being perhaps more dependent on selection of varieties with reference to soil, climate, location, and other conditions than any other fruit industry. The writer has seen such radically different results with the same varieties, planted in vineyards only a short distance apart, that it would hardly seem possible they were the fruit from the same variety.

It must first be decided whether to grow raisin, table, or wine grapes. Usually it will be well to select such varieties as have proved valuable for such purposes in the immediate vicinity. Should a grower embark in an entirely new district, where grape growing has not been tried, he will have an opportunity for displaying good judgment, and perhaps gain the distinction of becoming a pathfinder for those who follow in his lead, or perhaps, like Mr. Bull with his Concord, will raise a new variety adapted to the locality.

The American varieties most generally grown are Concord, Catawba, Moore *Early*, Missouri *Riesling*, Elvira, Isabella, Delaware, Norton, Niagara, Herbemont, Lenoir, Ives, Clinton, and Eumelan; the Vinifera varieties are Zinfandel, Valdepenas, Petit Sirah, Beclan, Mataro, Petit Pinot, Carignan, Mission, Chablis, Semillon, Sauvignon Vert, Green Hungarian, Berger, Thompson *Seedless*, Alexandria (*Muscat of*), Sultana, Feher Zagos, Flame Tokay, Emperor, and Cornichon.

PLANTING, PLOWING, AND CULTIVATING.

Throughout the Eastern States vineyards are usually planted in rows 8 feet apart, with the vines 8 to 10, even 12, feet apart in the rows. A plain trellis of posts, 24 by 30 feet apart, with two parallel wires, the first 18 to 20 inches from the ground and the second 36 inches, is mostly used, but in some instances a grower uses three wires (Pl. XLVI). Of late years many use the Munson trellis or a modification of it. In California the usual method has been to plant 7 feet apart each way, no trellis but simply stakes being used. This enables growers to plow and cultivate lengthwise and crosswise (see Pl. XLVII). There is a tendency to plant farther apart, some planting 8 by 8, others 6 by 10, and others 9 by 9 and 8 by 10. The writer prefers to plant 6 by 10 in most localities. This divides the distance in such a manner as to make the plowing, cultivation, etc., better, easier, and cheaper. The vineyards are all plowed twice. In the first



A TYPICAL EASTERN VINEYARD, NEAR BROCTON, N. Y.

FIG. 1.—HARROWING A CALIFORNIA VINEYARD PRUNED TO CANES.

FIG. 2.—PLOWING A CALIFORNIA VINEYARD PRUNED TO SPURS.

plowing the soil is thrown away from the vines, and in the second it is thrown up to them again. The vineyards are cultivated frequently early in the season. In the Eastern States too late cultivation, it is claimed, keeps the vines growing too late in the season, causing much unnecessary growth of wood, which does not ripen and weakens the vine. In California cultivation is abandoned after the spring rains are over. Pl. XLVIII shows a California vineyard in its first and its third year.

PRUNING AND GRAFTING.

So many different methods of pruning and grafting are practiced that the details of them can not be discussed in this paper. In the Eastern States the Kniflin system or some modification of it is mostly used. However, this varies greatly. In California two principal methods are practiced, commonly called cane and spur pruning. All of the systems have one underlying principle. As the grape bears its fruit mainly on shoots on the wood of the previous year's growth, the pruning should be so as to renew the wood at a given point from year to year, thereby regulating its production and keeping the plant thoroughly shaped and under constant control. With a thorough knowledge of the nature of the vine nothing is easier than to prune it correctly. Perhaps the nature of no fruit-bearing plant is so poorly understood by the average horticulturist as the vine. There are many who easily learn to prune fruit trees who fail to master the vine, and the same statement is equally true of grafting.

INSECTS AND DISEASES.

In many of the Eastern States, the black-rot, anthracnose, and mildew have wrought such serious damage that many vineyards have been abandoned. In some sections the grape rootworm and the thrips have been very destructive. In California the Phylloxera and the Anaheim disease have worked very serious and extensive injury, and it will require systematic experiments and earnest work and study to cope with them.

PICKING, MARKETING, AND STORING GRAPES.

In picking, the grapes are placed either in boxes or trays (Pl. XLIX). Those selling in baskets accept the price of the day as satisfactory or send to commission houses to sell on commission; others who are fortunate enough to have built up a reputation sell on direct orders at fixed prices. Those disposing of the product in bulk sell the entire crop at a stipulated price per ton, delivered at the wineries or aboard cars, and receive their settlement after the last of the grapes have been delivered. Quite a few sell their crops on the vines at so much an acre, or a stipulated sum for the entire crop, the buyer

in such instances doing all the work, picking, hauling, etc., and assuming all risks.

The methods of picking and packing practiced in the leading table-grape districts of the country are as follows: Grapes are picked in trays, all the stems being placed upward; the grapes are then allowed to wilt at least forty-eight hours, but are often stored away in the trays in cool, dry rooms, frequently as long as two months, and in extreme cases even longer. From these trays the grapes are carefully picked over, all decayed and inferior berries being removed; they are then packed in 4-pound baskets for shipment. In some of the less up-to-date sections, larger-sized baskets are still used. Some of the buyers have their own packing houses, but as a general rule each grower does his own packing, the baskets and labels being furnished by the buyer. In order to insure honesty and good quality, each packer receives his number, which goes on every basket furnished by him. The baskets are loaded into the cars and sent directly to the principal markets.

Late storage is practiced with good success. A leading packer at Hammondsport, N. Y., informed the writer that in 1901 he shipped his one hundred and seventy-fifth and last car the 6th of May. The different varieties are stored in separate houses. The houses are cooled by means of ventilating doors on the ground floor, around the sides and at the ends of the buildings, and also by ventilators with strong heating lamps in them overhead. The temperature is constantly watched by means of electric thermometers, and whenever there is a cool spell, either day or night, the doors and ventilators are opened, and if necessary the lamps are lighted to create a draft. In this way the temperature is often lowered as much as 10 degrees in an hour. In 1845 the first shipment of a crop of grapes (consisting of 50 pounds) was made from the Hammondsport district to New York City by way of the New York and Erie Canal. The grapes sold well, and the next year the grower shipped 300 pounds. Now, about 30,000 tons are grown in the same district, 15,000 tons of which are shipped to the different markets, and 15,000 tons converted into wine.

COST AND RETURNS FROM AN ACRE OF VINEYARD.

The cost of an acre of vineyard varies considerably, owing mainly to differences in the character and price of the land. A fair average estimate would be about $200 an acre. The average annual returns are from $125 to $500 an acre, while the annual cost of maintenance, including interest on capital invested, is from $40 to $75. The yield in tons, the number of gallons of wine per ton, and the quality of the grapes and wine vary greatly with the methods pursued, the soil, climate, locality, season, and varieties. In some seasons the quality is superior, while in others the quantity is heavy. Usually the heavier the crop the poorer the quality, and vice versa.

FIG. 1.—A CALIFORNIA VINEYARD IN ITS FIRST YEAR.

FIG. 2.—A CALIFORNIA VINEYARD IN ITS THIRD YEAR.

The Raisin Industry.

ORIGIN AND GROWTH.

Almost all the raisins of the United States are produced in California. In fact, so few are grown outside of the State that it can be called a California industry. Few branches of horticultural industry in this country have so completely captured the home market as this one.

The introduction of raisin grapes was really only a part of the introduction of choicer varieties of Viniferas into California. In 1851 Col. Agoston Harazthy grew Muscatels from the seed of Malaga raisins. On March 25, 1852, he imported the Alexandria (*Muscat of*), and on September 27, 1861, the Gordo Blanco and Sultana from Spain and the White and Red Corinth from the Crimea. He was the first to introduce raisin varieties into the State. Another importation of Alexandria (*Muscat of*) was made by A. Delmas in 1855 and planted at San Jose, Cal. G. G. Briggs, of Davisville, imported the Muscatels from Spain, while R. G. Blowers, of Woodland, started the raisin vineyard of Gordo Blanco with cuttings received from Colonel Harazthy. These were the first two successful raisin vineyards in the State. Both of these vineyards produced raisins as early as 1867, but it was not until 1873 that their raisin crops cut any figure in the market, when they amounted to nearly 6,000 boxes. In the fall of 1873, 25 acres of Alexandria (*Muscat of*) were planted in the Eisen vineyards, near Fresno. In 1876 and 1877 T. C. White planted the Raisina vineyard with Gordo Blancos, and in 1877 and 1878 Miss M. F. Austin planted the same variety at the Hedge Row vineyards. Col. William Forsyth interested himself in raisin growing in 1882. From that time on raisin vineyards multiplied so rapidly near Fresno that in 1887 raisin production was recognized to be the leading industry of that neighborhood. In 1873 John North planted Alexandria (*Muscat of*) at Riverside, and three years later raisin-grape growing had become general there. R. G. Clark planted the first Muscats in El Cajon Valley in 1873, but most of the vineyards of that district were not planted until 1884 to 1886. In Orange County, McPherson Brothers made their first plantings in the seventies near McPherson. The industry grew so that Robert McPherson, the largest grower, became at one time not only the largest packer and dealer in the district, but the largest in the State.

Many changes have occurred since the establishment of the raisin industry in Orange County, and now Fresno has become the center, the conditions there being exceptionally well suited to the growing and the curing of raisins. The raisin-producing section comprises ten counties—Fresno, Kern, Kings, Madera, Merced, Orange, San Bernardino, San Diego, Tulare, and Yolo. The profits from an acre differ materially, varying from $50 to $500, a fair average being from

$125 to $150. It takes from 3 to 4 pounds of grapes to make 1 pound of raisins. The product of about 65,000 acres is at present converted into raisins, it being desired to cure only enough to meet the demand. The demand for the last five years has been about 80 million pounds, or only 1 pound per capita for the United States.

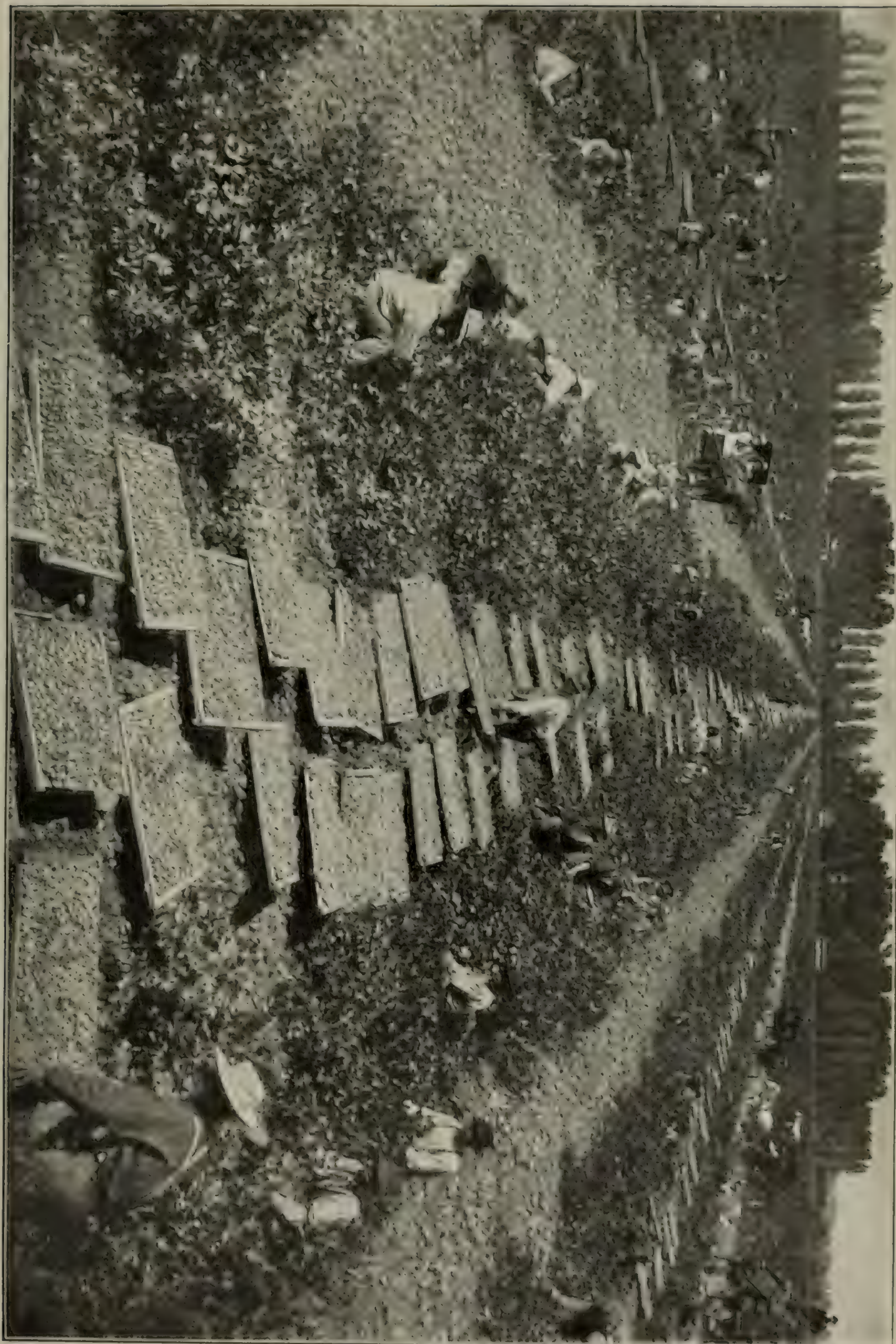
CULTURAL CONDITIONS.

In the raisin-producing section of California the country is so level naturally that not much leveling is necessary. The soil varies considerably, the deep gray alluvial bottom land being considered the best for Muscatel grapes. The pruning, planting, and cultivating of a raisin vineyard is much the same as in other California vineyards. (See Pl. XLVII.)

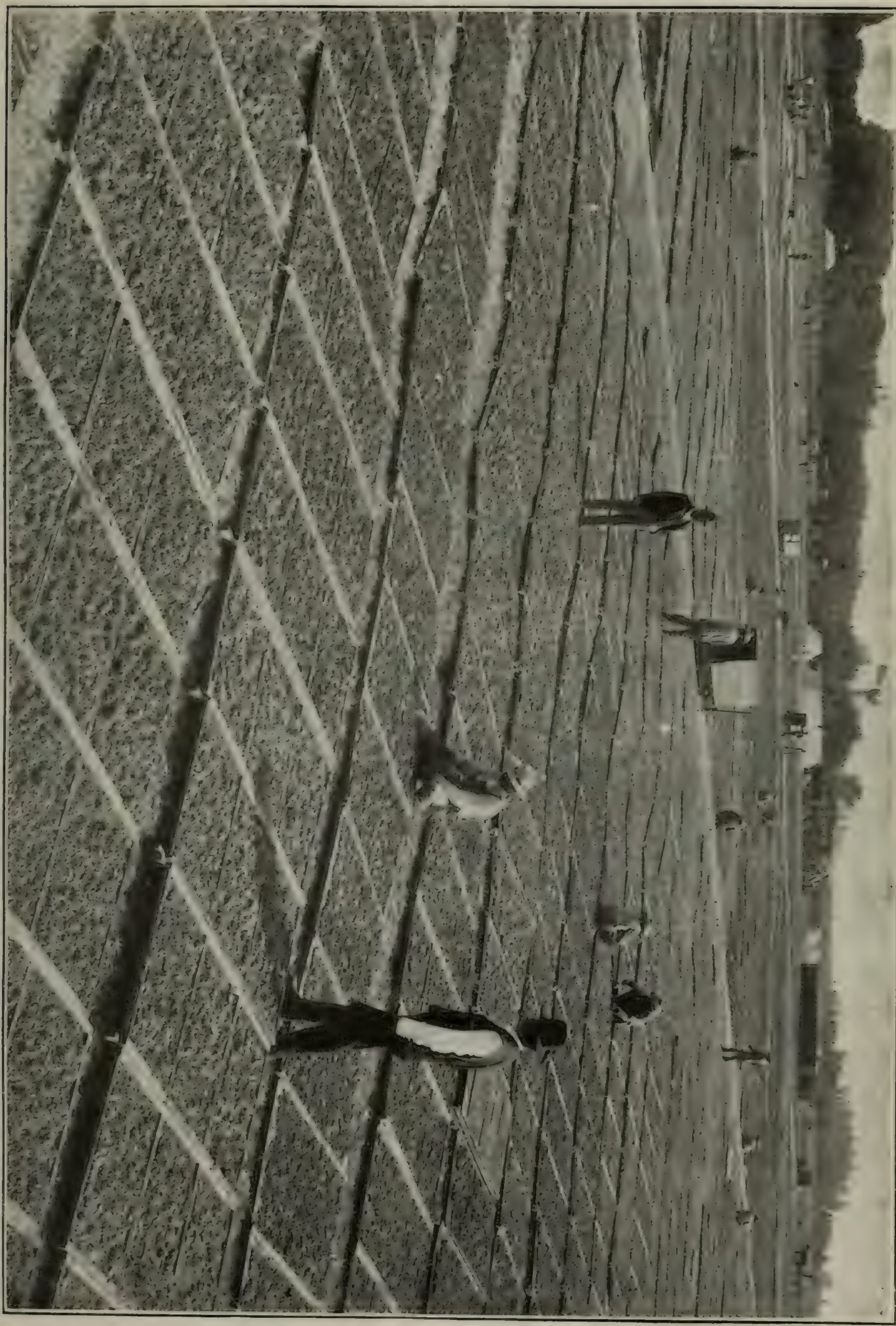
Crops can be grown without irrigation, but it is practiced because it increases the size of the fruit, and therefore increases the yield. Two irrigations are necessary, one early in the summer and another when the berries begin to ripen. Before irrigation was so extensively practiced, water was usually found at a depth of about 18 feet; now much trouble is experienced in some localities on account of the lands becoming water-logged. In the hottest time of the summer the thermometer has stood as high as 114° F. in the shade for a day or two at a time. The highest average is about 90° F., while the average in July and August is about 85° F. in the shade. The nights are always much cooler than the days. The coldest weather in winter is 18° F. above zero. The summers are rainless and the nights are so free from dew or moisture that a piece of tissue paper after lying out all night is crisp and stiff the next morning, without a particle of moisture showing. The rainfall averages 13 inches. The principal rains occur in January and February, with some showers in October. Frequently it rains enough in November to cause considerable damage to partially dried raisins and grapes. It is then that the Japanese laborers watch the predictions of the Weather Bureau, and when rain is indicated ask as high as 50 and 75 cents an hour for turning and covering the trays of raisins that are out in the vineyards. So familiar has this practice become that the school children who are large enough get excused from school for the work. In fact, the labor question is one of the most serious problems the growers have to contend with. The Chinese and Japanese laborers (especially the Japanese) control the situation, and make from $2 to $3.50 and even as high as $4 per day picking grapes. (See Pl. L.)

HARVESTING AND PREPARING THE CROP.

Grapes are ripe by the middle of August, the season often lasting into November. The average time of drying and curing a tray of raisins is about three weeks, all depending on the weather. The earliest picked grapes dry in ten days, and the later ones often take



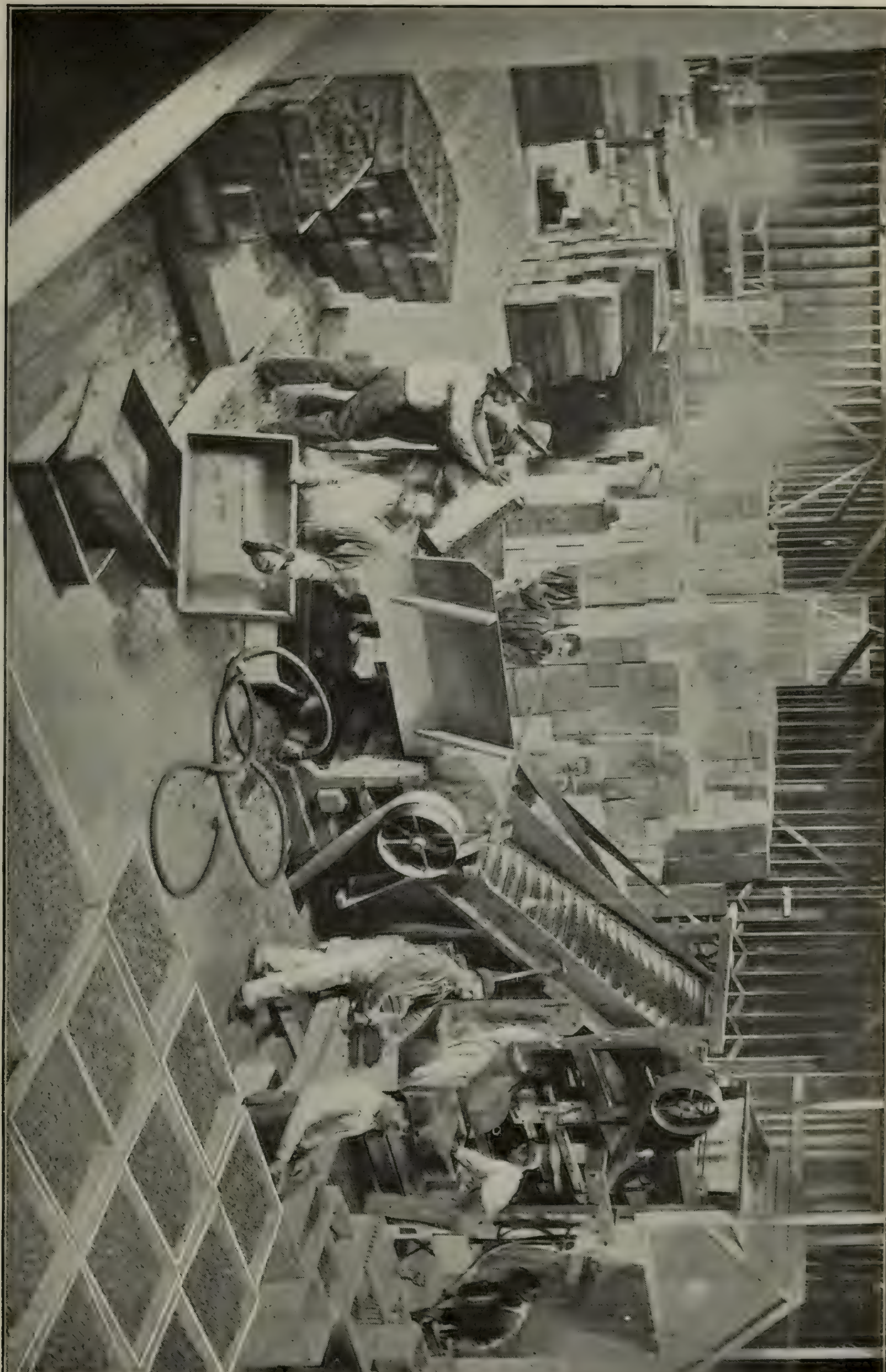
PICKING RAISIN GRAPES IN CALIFORNIA.



DRYING SEEDLESS RAISINS IN CALIFORNIA.

FIG. 1.—PACKING RAISINS IN LAYERS IN CALIFORNIA.

FIG. 2.—PACKING SEEDLESS RAISINS IN CALIFORNIA.



STEMMING RAISINS IN CALIFORNIA.

four weeks and even more. The method of drying is very simple. The bunches are cut from the vines and placed on shallow trays (Pl. LI) 2 feet wide, 3 feet long, and 1 inch high, on which the grapes are allowed to sun-dry, being turned from time to time by simply placing an empty tray top side down on the full one, then turning both over, and taking off the top tray. After the raisins are dried they are stored away in the sweat boxes until they are packed and prepared for shipment. Some of the larger growers, in order not to run so much risk in drying on account of rain, and also to enable them to handle the crop fast enough, have curing houses, where the curing is finished after having been partially done outside. The seeding, grading, packing, and shipping have become separate branches. (See Pls. LII and LIII.) In the season of 1898 and 1899 60 plants were engaged in this part of the work, the most of them located in the Fresno district. These establishments furnished employment for 5,000 employees, and the aggregate wages paid out to them each month during the season was nearly $250,000.

EXPORTS, PRODUCTION, AND IMPORTS.

The exports of California raisins first became of sufficient importance to be separately stated in the official reports of the Treasury Department in the fiscal year ending June 30, 1892. Raisins have since been sent in small, it may be said experimental, quantities to all parts of the world, and the trade has grown until in 1898 the exports amounted to 3,109,639 pounds and in 1902 to 2,323,274 pounds.

The following figures serve to show how gradually and systematically California has monopolized the raisin trade of this country:

Raisins produced and imported.

Year.	Raisins produced.	Raisins imported.
	Pounds.	*Pounds.*
1885	9,400,000	53,702,220
1890	38,000,000	36,914,330
1895	91,300,000	15,921,278
1898	80,631,000	6,598,833
1902	100,000,000	6,563,302

The year 1894 was the record breaker, when 103 million pounds were produced. Raisin growers claim that this was made possible by the duty of 2 cents a pound on imported raisins. Consul Ridgely says, so cheaply and abundantly are raisins grown in Malaga, that were it not for the duty Malaga exporters would undoubtedly undersell California growers. The season's opening prices for raisins the last four years have been: Per box of 20 pounds—Imperial clusters, 6 crown, $2.50 to $3; Dehesa, 5 crown, $2 to $2.50; Fancy, 4 crown, $1.50 to $3; London Layers, 3 crown, $1.20 to $1.60. Per pound in 50-pound box or

bag—loose Muscatels, 4 crown, $4\frac{3}{4}$ to 7 cents; loose Muscatels, 3 crown, 4 to $6\frac{1}{2}$ cents; loose Muscatels, 2 crown, $2\frac{3}{4}$ to 6 cents; seedless Muscatels, $3\frac{1}{4}$ to $6\frac{1}{2}$ cents.

Wine, Brandy, and Champagne Manufacture.

The manufacture of each of these products from grapes constitutes an important industry in itself, and can not be described in this paper. According to the United States census for 1900, of the 169,055 gallons of sparkling wines manufactured, California reported 8,880; Ohio, 15,600; Missouri, 2,940; and New York, 113,435 gallons. This shows that New York produced more than twice as much as all the other States together.

The yearly production of wine from 1887 to 1891 in California was from 15 million to 20 million gallons, and the price fell below 10 cents a gallon, notwithstanding the fact that the demand had increased a million gallons annually; notwithstanding also that half a million gallons of brandy had been made in 1886, with the same amount in 1887, and, in the three years next succeeding, a million gallons annually; that in the southern part of the State 20,000 acres had been destroyed by the Anaheim disease; that in Napa and Sonoma counties the bulk of the vineyards were wholly or partially destroyed by the Phylloxera, and that about 600 carloads of dried grapes had been shipped in 1889 and 1891. The state of affairs then existing can hardly be imagined. Many growers became bankrupt; those who had sufficient means pulled up their vines and planted other fruits or raised hay and grain; a few, who believed in the ultimate success of the industry, persevered, and replanted the vineyards which the Phylloxera had destroyed. In 1892 the heavy frost which prevailed over the leading wine districts cut the crop down to 15 million gallons, and prices went up. About this time the California Wine Association was formed for mutual protection by the largest dealers. In 1894 the California Wine Makers' Corporation was organized by the wine makers of the State for a similar purpose, and set the price in wholesale lots to the dealers at 15 cents. The corporation, which had secured enough of the State's output to control prices, entered into a contract by which an association of the principal dealers agreed to purchase from the corporation 5 million gallons annually. All went well until some of the producers became dealers and undersold the association. This resulted in a rupture of the two associations. At the next annual meeting of the members of the Wine Makers' Corporation its board of directors was instructed to enter the markets of the world. A long war of cutting prices for standard wines was the result, which was embittered by the phenomenal yield in 1897 of 27 million gallons dry and 7 million gallons sweet wine, and prices again became low. The next season witnessed a great shortage in crop, only $18\frac{1}{2}$ million gallons of both dry and sweet wines being produced. This

led to better feeling between the factions, and brought about higher prices. Commercial statistics show that the trade requires 22 million gallons yearly—16 millions for export and 6 millions for coast consumption, 4 millions of this being sweet wine. The demand is increasing by 2 million gallons annually, so there is a shortage instead of overproduction, and the wines of 1900 changed hands at from 15 to 20 cents in wholesale lots from producer to dealer. The 1901 crop brought from 20 to 35 cents a gallon, and the price for the 1902 crop will be about the same.

The following prices of grapes for the last season will serve to illustrate the differences existing in the quality of grapes for wine-making purposes: In the Napa district, $30 to $35 per ton; Sonoma, $22.50 to $30; Santa Clara, $25; Livermore, black grapes $20, white $30; Contra Costa and Alameda, $25; south of the Tehachipi, from $12.50 to $15.

The investment of capital in the California wine industry may be summed up as follows:

Vineyards, at $200 an acre	$38,000,000
Nearly 500 registered distilleries	200,000
About 40,000,000 gallons cooperage	14,000,000
Cellars and machinery	10,000,000
Capital to carry on business	10,000,000
Total	72,200,000

This industry, which is not much more than fifty years old, gives employment to nearly 60,000 persons.

SOME OF THE LARGE VINEYARDS OF CALIFORNIA.

To the late Senator Leland Stanford, founder of the Leland Stanford Junior University, belongs the distinction of having had the largest vineyard in the world, comprising nearly 5,000 acres, and being over 7 miles long. The wineries on the place cover more than 6 acres of roof surface, and during the years the writer had charge of them from 2½ million to 3 million gallons of wine were made annually, from 400 to 850 tons of grapes being crushed daily.

At Asti the Italian-Swiss colony has 1,700 acres in bearing vineyards. On the place are extensive wineries, with the largest wine vat of the world, holding 500,000 gallons.

Near Cucamonga the Italian Vineyard Company has, during the last three years, planted nearly 2,000 acres in one field. The Riverside Vineyard Company during the same time planted 2,500 acres in one vineyard.

The California Wine Association, at its own wineries, in 1902, worked up 150,000 tons of grapes and at its leased wineries enough more to make 225,000 tons. In the fall of 1902 the association paid out in cash over $5,000,000 for grapes. Throughout the State there are quite a number of vineyards of 500 acres each.

SOME SUCCESSES AND REVERSES.

New York being the leading State for the growing of American grapes and California for the Vinifera varieties, a brief review of the conditions and prices that have prevailed in those States will give a fair insight into the past history of the industry.

In New York thirty years ago 5 and 6 cents a pound were received for grapes. In 1889 the price per pound for basket lots was 3 cents, in 1893 about 1½ cents, in 1898, 1899, and 1900 about three-fourths of a cent, and in 1901 about 1½ cents. In 1890 and 1891 bulk grapes brought an average of $20 a ton, and in 1892 an average of $18 per ton. From that time the price gradually diminished until 1896, when the average was no more than $9 a ton, and one particular lot of 100 tons was sold at $4 per ton. Since then the average price has been about $12 a ton until 1901. For some years the price of grapes failed to pay expenses of growing. The cultivation, or rather the care, of the vineyards had ceased to be a labor of love and had become one of necessity. The question was, Will the vineyards pay expenses then? In order to make them do so the vines were overcropped, expenses were curtailed, and each grower tried to do as much of the work as possible himself. Much of the work was carelessly done, much was left undone, and much was done at the wrong time, resulting in injury to the vines from which they will never entirely recover. Such were the conditions at the beginning of the 1901 vintage, when, on account of the great shortage of the grape crop in other sections and a short crop of other fruits, especially apples, with a lively demand for unfermented grape juice[a] and cheap clarets, grapes were in great demand and much better prices were realized than for six years previous.

In California, in 1876, Mission grapes sold for from $7.50 to $10 per ton and other varieties from $14 to $18 per ton, so that many growers having poor shipping facilities turned hogs in to harvest the crop. In 1879 Mission grapes brought $10 to $12 and choice varieties $20 to $25 per ton. Prices then went up rapidly, and from 1880 to 1882 Mission grapes sold at from $15 to $20 per ton. The extreme prices had indeed been reached, and those growing grapes became rich in a few years. Everybody who could possibly plant an acre of vineyard did so, and in a few years the production far exceeded the demand, when prices dropped until in 1886 grapes brought only from $6 to $10 per ton.

After years of successes and reverses, shortages and overproductions, the industry in the East and West has gradually settled down to a more solid business basis. Grafting stocks are in good demand, the prices of grapes and wine are steadily increasing, and much new area is being planted in vines. The new plantings the last few years

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[a] The manufacture of unfermented grape juice is already a considerable industry, and is rapidly increasing. See Bulletin No. 24, Bureau of Plant Industry, U. S. Dept. Agr.

have been exceedingly large, and there is every indication that they will be even larger. It is to be regretted that in California, where so many thousands of acres have already been destroyed by the Phylloxera, many of those making new plantings are not using resistant stocks, and therefore many of the vineyards will not live long enough to bear a crop. In California, and the eastern section of the country as well, due regard is not being paid to the selection of the proper varieties of fruiting sorts, and returns will be diminished accordingly. This is especially to be regretted, for not only should growers, profiting by past experience, avoid errors previously made, but also improve methods wherever possible.

Future of the Industries.

Looking back to the middle of the last century, when just a start had been made, when growers were beginning to believe something might perhaps be done in the way of a commercial grape industry, and taking a glance at what such States as Virginia, Missouri, Ohio, New York, and California have done, especially New York and California, there is good reason to believe that the industry in this country may yet reach a development proportionate to that of other agricultural interests. Achievements at expositions and on public occasions, however, are really far in advance of what has been done in the way of production. This may easily be seen when the product of this country is compared with that of other countries. In 1901 France produced of wines 1,523,233,200 gallons; Italy, 1,013,760,000; Spain, 520,080,000; Portugal, 155,760,000; Austria, 116,160,000; Roumania, 87,120,000; Chile, 85,120,000; Russia, 76,560,000; Bulgaria, 73,920,000; Germany, 60,720,000; Argentina, 55,440,000; Turkey, 50,160,000; Greece, 32,300,000; Switzerland, 31,680,000; United States, 29,500,000, and Servia, 23,760,000 gallons. However, the industry in the United States is as yet in its infancy. A beginning has just been made in a commercial and businesslike manner to improve methods and expand markets. California has produced and sold annually the last ten years an average of 20 million gallons of wine, 2 million gallons of brandy, and 80 million pounds of raisins.

So far the raisin industry of this country has only supplied the small home demand of 80 million pounds, whereas the present population, were it to consume as much per capita as some other countries, say Great Britain, would now use 400 million pounds annually, not to say anything of extending markets and exporting to other countries.

When it is considered that France in 1901 produced 1,523,233,200 gallons of wine, while this country produced 29,500,000 gallons, and that the Golden State alone has a grape and wine producing area almost equal to the whole of France, some idea can be formed of the great possibilities of the industry.

A beginning has been made; what the industry will be remains largely with those who engage in it. No reason presents itself why varieties of grapes should not be cultivated wherever the wild vines flourish, and some of these are found in nearly all parts of the Union.

Two important lines of work need thorough experimental investigation in the near future. One of these is the determination of the relative adaptability of resistant stocks to the various types of soil found in the commercial grape regions of the Pacific coast and of the congeniality of the leading commercial varieties of the Vinifera type to such stocks. The other is the development of varieties suitable for those districts east of the Rocky Mountains in which the native grapes that have developed in New England, New York, and other northern districts are not adapted to the climatic conditions. The field which is in special need of such varieties includes the South Atlantic and Gulf States. With the wealth of native grapes in this region and the improvement of the grape already accomplished through hybridizing, it appears almost certain that varieties of choice quality, resistant to the fungous diseases that prey upon the Vinifera and Labrusca types in the South, may yet be developed, and in the not distant future make grape culture as remunerative and certain in its results in this region as it already is in other portions of the country.

FLAXSEED PRODUCTION, COMMERCE, AND MANUFACTURE IN THE UNITED STATES.

By Charles M. Daugherty,
Of the Division of Statistics.

INTRODUCTION.

Evidently impressed with the vicissitudes that flax culture has undergone in the United States, some one has aptly remarked that the flax crop is one of the curiosities of agriculture. The remark is peculiarly suggestive. For, although there is nothing strange or unusual in the present method of cultivating flax in this country, the crop being drilled, harvested, thrashed, and marketed under natural and mechanical conditions almost identical with those of cultivating, garnering, and marketing the small grained cereals, spring wheat, spring rye, and oats, nevertheless, there are other features connected with its history that make the flax crop unique among agricultural products.

The flax plant is the source of two extremely valuable economic products—the one a fiber derived from the straw and noted from time immemorial the world over for its strength, beauty, fineness, and length of staple; the other, a seed rich in an oil of such superior drying qualities as render it an indispensable ingredient in paint and varnish, and in the manufacture of linoleum, oilcloth, printer's ink, patent leather, and a few other products. The full value, however, of both straw and seed from one and the same crop has never been realized on a large scale in practical agriculture. The cultivation of flax for fiber, requiring, as it does, the sowing of from 2 to 4 bushels of seed to the acre and the pulling up of the plant by the roots by hand a little before the seed is fully ripe, impairs the quality and reduces the quantity of the crop of flaxseed. The cultivation of flax for the seed, on the other hand, requires a seeding of but 2 to 3 pecks to the acre, and results in an increased yield of seed but a coarser straw; and the subsequent mowing and thrashing of the crop by machinery tends to destroy the value of the straw for textile uses. As a business proposition, therefore, flax is almost universally raised either chiefly for the fiber or exclusively for the seed, either as a source of raw material for the linen factory or for the linseed oil mill. And, with the exception of Russia, which is an important producer of both seed and fiber, the principal flax-producing countries of the world have become distinctly

divided along these lines. In the European countries, with Russia as the prime factor, flax is cultivated chiefly for the fiber; in the United States, Argentina, and British India, which with Russia produce the world's commercial crop of flaxseed, the plant is cultivated almost exclusively for the seed. In the United States, as will be seen further on, there has been a gradual conversion from one system of cultivation to the other. Many hundred gallons of oil from the seed of this valuable plant have been utilized in making the printer's ink used within the past half century in demonstrating the possible utility and theoretical value of the thrashed and tangled straw. The Department of Agriculture, through its Office of Fiber Investigations, in 1898, published a report[a] on the possible utilization of flax straw. Nevertheless the economic value of the flax crop of the United States to-day is represented almost entirely by the seed; the straw, with a few unimportant exceptions, is a total waste.

THE GROWTH AND DEVELOPMENT OF FLAXSEED PRODUCTION AND MANUFACTURE.

Flax was originally introduced upon this continent solely for its fiber, and bears the distinction of being among the first agricultural products transplanted from the Old to the New World; chance records of its culture occur within a few years after the landing at Plymouth. For a period of more than 150 years thereafter, or until cheaper cotton fabrics began to supplant linen ones, the extensive culture of flax for fiber played an especially important part in the material progress of the country, becoming, as it did, the basis of that famous household industry whose homespun products were necessities of life second only to food. The seed, for which there was obviously a limited domestic demand, gradually developed into an important article of export, and in 1791 exports of flaxseed from the United States amounted to 292,460 bushels, a larger quantity, it is curious to note, than was exported in any year thereafter until 1892.

The invention of the cotton gin in 1792 placed a check upon the production of flax for fiber in the United States from which it never recovered, and indirectly gave the first slight impetus to the cultivation of flax for seed that has culminated in the present century in making this the leading flaxseed producing country of the world. In the absence of positive historical evidence, it can not be far wrong to assume that from about this time dates the manufacture of linseed oil in the United States, at least on anything like an important scale. In 1810 there were 283 linseed oil mills in existence in fourteen States of the Union, 171 of them in the single State of Pennsylvania. Small affairs they were, it is true, probably operated under pressure obtained from the most primitive appliances of mechanical power; their total annual

[a] Report No. 10, Office of Fiber Investigations, U. S. Dept. of Agr., "Flax culture for seed and fiber in Europe and America."

output of oil amounted to only 770,083 gallons, representing doubtless not 300,000 bushels of seed—a smaller quantity than could be crushed in a like period by a single modern mill of less than average capacity. But they are of interest as illustrating the early conditions of a minor industry in which the United States was afterwards to lead the world.

In 1839 the first cargo of flaxseed ever brought into the United States was imported from Russia. A few years later ships carrying ice to India found it profitable to load return cargoes of flaxseed. By 1850 India had practically monopolized this trade, and for a period of twenty years thereafter shipped annually a larger quantity of flaxseed into the United States (larger by fourfold in some years) than the States themselves produced.

Flaxseed production in the Atlantic coast States had declined, and excepting in New York, Pennsylvania, Virginia, and North Carolina had practically disappeared altogether. The culture of the crop had migrated across the Alleghenies, and from 1850 to 1860 half the entire crop of the country was grown in Ohio and Kentucky. Linseed oil mills, moreover, were being established in these States with a capacity capable of crushing the Western-grown crop, and the only alternative of many mills in the East had been to go out of business or to import seed. From this state of affairs arose a division of the industry, in the parlance of the trade, into Eastern and Western mills, a division not merely geographical, but founded upon essentially different commercial conditions that continued in greater or less force until the great increase of flaxseed production in the United States in 1891. The Eastern mills, though still crushing the seed grown in the Atlantic coast States, became dependent for supplies principally upon seed imported from India. The Western mills were the primary markets for seed grown almost at their very doors. The apparent advantage of the latter in being near the base of their supplies was largely offset by the fact that the seed from India was larger of grain and yielded oil greater in quantity and of better quality than did seed of American origin. The location of the Eastern mills on or near tidewater also gave them superior advantages for exporting the valuable by-product, linseed oil cake.

Under these conditions imports increased rapidly from a little over a half million bushels in 1850 to almost 4 million bushels in 1875. Production in the Western States, expanding into new territory, gradually increased beyond the crushing capacity of the Western mills, and larger and larger quantities of the surplus of good years found its way annually to the Eastern crushers. Naturally the relative cheapness of Western seed favored its substitution for the imported product. But the supply was unequal to the demand, and imports from India continued to figure in the Eastern markets, usually to the extent of from a half million to 2½ million bushels a year, until 1892. In that year the United States for the first time took rank among the

surplus flaxseed producing nations of the world, and became an exporter of some importance and permanency; regular importations on a large scale ceased; the flax crop had virtually disappeared from the Eastern States, and the Eastern mills, in so far as they had been dependent upon foreign seed, changed their base of supplies from Calcutta and other points to the domestic markets at Chicago and Duluth. On only two occasions since have foreign importations of large proportions been renewed. The short crop of the United States in 1894 was followed by imports amounting to over 4 million bushels. And a speculative condition in the flaxseed trade in the crop year 1900–1901 resulted in an importation of over $1\frac{1}{2}$ million bushels, the imports of the latter year being of especial interest in that they came almost wholly from a new source of supply—Argentina. For the past dozen years, therefore, with but two exceptions, the linseed oil mills of the East have been run almost entirely on domestic seed, a condition that had not existed in two consecutive years before for over a half century.

During that half century the linseed oil industry had been revolutionized. In the East the disappearance of flaxseed from cultivation had annihilated the small local mills; the importation of seed from abroad and the construction of new transportation lines at home had forced others to change their location from the old to new and more economical bases of operation; improvements in linseed oil machinery, moreover, had enabled the remaining mills greatly to enlarge their crushing capacity. And, later, the concentrative spirit of the age tended steadily toward the embodiment within the limits of a few establishments, and the localization at a few points of commercial vantage, of an industry that had formerly been widely dispersed. The thirty-odd mills that as late as 1870 had existed in the Atlantic coast States from North Carolina to Massachusetts, and inland as far as the Alleghenies and the western boundaries of New York and Pennsylvania, are at present represented by 13 mills of large capacity as a rule, located generally with reference to the bases of seed supply or to the advantageous sale of the manufactured products. The two principal crushing centers of the Eastern States now are Buffalo, with 4 mills, and New York, with 2 mills, the former city possessing the advantages of all-lake transportation from the great primary market, Duluth-Superior,[a] the latter that of being the center of a great consumptive market for linseed oil, and of having exceptional advantages for the importation of flaxseed, when necessary, and for the exportation of linseed oil cake. Philadelphia, with 3 mills, ranks next as an Eastern manufacturing center, with a crushing capacity about one-third that of the city of New York. The only other Eastern cities of noteworthy importance in this industry are Amsterdam, N. Y., and Pittsburg, Pa. Two mills of limited capacity, located,

[a] Cited in trade journals as one port.

respectively, at Troy, N. Y., and Allegheny, Pa., complete the list of Eastern mills. The combined crushing capacity of the mills located at the above-named points may be estimated, approximately, at from about 10½ million to 12½ million bushels of flaxseed a year, although it is likely that their actual annual crush has never exceeded three-fourths of the lesser quantity.

MIGRATORY CHARACTER OF THE WESTERN CROP.

In the West the history of flaxseed production and linseed oil manufacture presents some especially interesting features. As to the crop itself, the most remarkable characteristic is that it has been migratory. Always a minor crop and specialized almost in entirety within the area of a few States, it has, within the past half century, migrated from one area of production to another, increasing enormously in volume at every stage of its progress, until it has traversed the entire country, almost State by State, from its original home in Kentucky and southern Ohio to its present area of principal production in North Dakota, Minnesota, South Dakota, Iowa, and Wisconsin. The product of this area is known as the Northwestern crop. A diversion of a portion of the crop from the general direction of migration has resulted in another smaller but distinct area of production in Kansas, Missouri, and Nebraska, Oklahoma and Indian Territory. The product of this area is known as the Southwestern crop. Strange as this migration seems, its causes are in no wise peculiar. The flaxseed crop of the West has been distinctively a "pioneer" crop. It has the common reputation when fertilizers are not used, as they seldom are on pioneer crops, of being, in so far as the reproduction of flaxseed is concerned, quickly exhaustive of the soil. From this and minor causes the flaxseed crop in the West seems simply to have abandoned in succession old areas upon which it had ceased to yield profitable returns and to have sought the rich, fertile lands of newly settled States.

In 1849 the flaxseed crop of the United States amounted to about a half million bushels, and Ohio, with about one-third of the total crop, was the leading producing State. In what is now the principal area of production—that is, the Dakotas, Minnesota, Iowa, and Wisconsin—flax culture, with the exception of an insignificant area in Iowa and Wisconsin, was absolutely unknown. For the next decade the total production of the country remained about stationary, and although Ohio retained her supremacy relative to the total crop, a slight tendency toward migration was manifest in a heavy increase in the small crop of Indiana. By 1869 the flax crop of the entire country had trebled; Ohio was still the leading producing State, and Indiana a close second, but a decided tendency toward further migration was manifest in a heavy increase in the flaxseed area of Illinois. From this date flax cultivation in Ohio began a steady decline. Ten years later the area of principal production had expanded until it embraced Iowa, and

the three States, Indiana, Illinois, and Iowa, were producing two-thirds of the country's 7 million bushel crop—Illinois first with a crop of 1,812,438 bushels, and Iowa second with 1,511,131 bushels. Flaxseed cultivation in Indiana and Illinois, however, soon underwent a rapid decline and within the next ten years lost its importance altogether. This crop in all States east of the Mississippi soon afterwards became practically a thing of the past. Minnesota in the meantime had become the leading producing State, surpassing even Iowa. Flaxseed cultivation had also been taken up on an extensive scale in South Dakota, and of the crop raised in the United States in 1889 (10,250,410 bushels) Minnesota, Iowa, and South Dakota produced almost exactly the same proportion as Indiana, Illinois, and Iowa had of the smaller crop of ten years previous. Next came the final stage in the migratory progress of the crop—the remarkable expansion of the area of principal production into North Dakota. Between 1889 and 1899 the yield of that State increased from 164,319 bushels to 7,766,610 bushels, and in the latter year the five States, North Dakota, Minnesota, South Dakota, Iowa, and Wisconsin, producing what is now known as the Northwestern crop, were credited with a combined yield of 17,668,672 bushels, or over 88 per cent of the entire crop of the United States. Flaxseed production in the Northwest, notably in North Dakota, has since increased with giant strides. In 1902 the entire crop of the United States amounted to a total of 29,284,880 bushels, and of this 15,552,000 bushels, or over 53 per cent, was the product of that single State. The crops of Minnesota and South Dakota also showed a marked increase, the older flaxseed producing State, Iowa, as might now be expected, showing a decline. The present importance of the five so-called Northwestern States with reference to this crop is illustrated by the fact that in 1902 their combined product amounted to 26,966,600 bushels, or over 92 per cent of the entire crop of this country.

Naturally arises the question of further migration. Does the small but increasing acreage now devoted to this crop in Idaho and Montana forecast a movement in that direction? Or will the area of principal production expand into the new lands of Manitoba and the Northwest Territories of Canada?

The Southwestern crop is distinguished from the Northwestern not so much by geographical limitations as by a difference in the oil content of its seed. Up to the time of the expansion of flaxseed production into Minnesota and South Dakota the entire crop of the United States had been, from the crushers' point of view at least, all of one variety, characterized by being smaller of grain and less rich in oil than that imported from foreign sources. Occasional attempts to transplant seed from British India had resulted only in its rapid reversion to the old American type. Soon after flaxseed cultivation

had been taken up on an extensive scale in South Dakota, however, the introduction of a foreign variety (by Russian emigrants, according to some authorities, and as an agricultural experiment according to others) resulted in a seed which, though not retaining all the characteristics of the original stock, was larger of grain and richer in oil than the old American seed. To the successful issue of this experiment was doubtless due in part the subsequent extensive development of flaxseed cultivation in the Northwest, that crop now consisting entirely of this kind of seed. But in the Southwest the improved variety has either not been cultivated at all, or when sown experimentally has not retained its original characteristics. As a consequence there are two different varieties of flaxseed produced in the United States, the small-grained seed of the Southwest, usually credited by crushers with yielding an average of 16 or 17 pounds of oil to the bushel (56 pounds) of seed, and the larger-grained seed of the Northwest, credited by the same authorities with a yield of from 18 to 20 pounds of oil to the bushel, the yield in all cases, of course, varying greatly with the climatic conditions under which the crops are grown and harvested. Under these adverse competitive conditions and from other causes flaxseed cultivation in the Southwest, as a whole, has naturally shown a tendency to decline, and the decline has been both absolute and relative. From 2,846,062 bushels in 1889 the crop fell in 1899 to 2,104,162 bushels, and in 1902 to 1,856,240 bushels; or, relatively, from about 27 per cent of the entire crop of the United States in 1889 to a little over 6 per cent of the total in 1902.

STATISTICAL HISTORY OF FLAXSEED CULTIVATION IN THE UNITED STATES.

The history of flaxseed cultivation in the entire flax belt of the United States for the past fifty-odd years, the rise and fall of its culture in certain States, the migratory progress of the crop, the enormous increase in the total production, and the specialization of the crop almost entirely within the area of a few States, are excellently illustrated by the following statistical statement, which gives the production by States in decennial years, according to the reports of the United States census, and also the yield in 1902 according to the initial number of a series of annual estimates recently undertaken by the Division of Statistics of the Department of Agriculture. For many years the flaxseed crop of the United States has practically all been produced in the Western States; hence only those States are given specifically in the statement. They are divided according to the custom of the trade into Northwestern and Southwestern, the now almost obsolete crops of Kentucky, Ohio, Indiana, and Illinois being included under the former classification only to illustrate more fully the migration of this crop.

Production of flaxseed in the United States.

State or Territory.	1849	1859	1869	1879	1889	1899	1902
NORTHWESTERN CROP.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
Kentucky	75,801	23,875	14,657	2,192	1,321	10	----------
Ohio	183,880	242,420	631,894	593,217	145,557	29,821	----------
Indiana	36,868	119,420	401,931	1,419,172	17,566	1,394	----------
Illinois	10,787	8,670	280,043	1,812,433	35,013	4,336	----------
Iowa	1,959	5,921	88,621	1,511,131	2,282,359	1,413,380	770,250
Wisconsin	1,191	4,256	112,019	547,104	68,227	140,765	496,100
Minnesota	----------	118	18,635	98,689	2,721,987	5,895,479	6,942,000
South Dakota	----------	----------	----------	26,757	1,801,114	2,452,528	8,206,250
North Dakota	----------	----------	----------		164,319	7,766,610	15,552,000
Total	315,503	409,680	1,547,800	6,010,700	7,237,463	17,704,323	23,966,000
SOUTHWESTERN CROP.							
Missouri	13,696	4,656	10,391	379,535	450,831	611,888	328,500
Kansas	----------	11	1,553	513,616	994,127	1,417,770	1,217,280
Nebraska	----------	2	404	77,805	1,401,104	54,394	116,000
Indian Territory	----------	----------	----------	----------	----------	15,030	42,000
Oklahoma	----------	----------	----------	----------	----------	5,050	152,460
Total	13,696	4,669	12,348	970,956	2,846,062	2,104,162	1,856,240
Total Northwestern and Southwestern crops	329,202	414,349	1,560,148	6,981,656	10,083,525	19,808,485	28,822,840
Total other States	233,110	152,518	170,296	189,295	166,885	171,007	[a] 462,040
Total United States	562,312	566,867	1,730,444	7,170,951	10,250,410	19,979,492	29,284,880

[a] Crop of Montana, Idaho, Oregon, and California only. The crop of these States moves westward and is manufactured in the two linseed oil mills located, respectively, at Portland, Oregon, and San Francisco, Cal., the only mills in the Pacific Slope States.

THE INTERNAL COMMERCE IN FLAXSEED.

The linseed oil industry in the West first developed into importance in Ohio, and as early as 1860 there were 26 mills in operation in that State, against 8 in all other territory westward to the Pacific Ocean. The Miami Valley, in the southwestern part of the State, was then the great flaxseed producing section of the West, and Dayton, Ohio, the principal crushing center. As, however, the principal area of flaxseed production migrated, decade after decade, northwestward, there occurred the singular phenomenon of the industry following in the path of migration until, checked by the cheap transportation facilities of the Great Lakes, by conditions incident to the sale of the products manufactured from flaxseed, and by other causes, the industry itself became in a manner stationary in its present location in the Lake region, while the principal area of flaxseed production migrated still farther into the now great producing States, North Dakota and South Dakota. The half hundred mills that were in active operation less than a quarter century ago in the interior of Ohio, Indiana, and Illinois, their existence originally dependent almost wholly upon

supplies of local-grown seed, have one after another been dismantled; and two small and irregularly operated mills at Dayton, Ohio, are now the sole relics of the industry in the interior of those three States. The manufacture of linseed oil in the West has become largely localized in cities on and near the Great Lakes, and in 1902 an annual active crushing capacity of between 10,250,000 and 12,250,000 bushels of flaxseed was represented by this localized branch of the industry. Over three-fourths of this total capacity is embodied in the five mills at Minneapolis and the six mills at Chicago, the remainder being represented by mills located as follows: Two active mills at Toledo, Ohio, and one each in Superior, Wis.; Milwaukee, Wis.; Redwing, Minn.; South Bend, Ind.; and Cleveland, Ohio.

As a direct consequence of this quasi separation of the industry from the area of principal production, there has grown up that immense internal commercial movement of flaxseed that to-day underlies the linseed oil industry, both East and West, of the United States—the commercial movement of the bulk of the supplies of raw material from the vast areas of agricultural production to the great distributing market, Duluth-Superior, and to the principal Western manufacturing centers, Minneapolis and Chicago. Limited crushing facilities in the principal areas of production are obviously the underlying causes of this traffic. In North Dakota and South Dakota there are no linseed oil mills in operation and but one (at Fargo) in existence. In Iowa the two mills located, respectively, at Des Moines and Sioux City represent the active crushing capacity of that State. In Wisconsin there are but the two mills, at West Superior and Milwaukee. In other words, in the four States which in 1902 produced upward of 20 million bushels of flaxseed there are but four active linseed oil mills, and their combined crushing capacity is equivalent to scarcely 7 per cent of those States' maximum production. Even the great importance in this industry of the fifth Northwestern State, Minnesota, depends almost wholly upon the mills located at the single center, Minneapolis. Moreover, the industrial conditions in the Southwest differ from those of the Northwest only in proportions. In the five States which produce what is commonly known as the Southwestern crop there are but four active linseed oil mills—two at St. Louis, one at Kansas City, and one at Fredonia, Kans. These mills have a combined capacity for manufacturing about a million bushels of seed annually, or, as estimated by the crop of 1902, a little over one-half of the Southwestern crop. The bulk of the surplus finds its way ultimately to the markets of Chicago. It is pertinent to note that flaxseed in its natural state has no domestic uses on the farm except for seeding purposes. Its economic value is dependent entirely upon the products derived from its manufacture. Every bushel of the commercial crop has for its ultimate destination the linseed oil mill, and the internal commerce in this product, therefore, involves the entire crop,

excepting the small proportion reserved for seeding purposes and that consumed by local mills in the producing territory. These quantities excepted, practically the total flaxseed crop of the United States moves directly from the areas of production to the three primary markets, Duluth-Superior, Minneapolis, and Chicago.

The final stage in the internal commerce of flaxseed is the distribution of supplies from these three primary markets to the Eastern mills and to those located along the shores of the Great Lakes. Since the phenomenal development of flaxseed cultivation in North Dakota, Duluth-Superior has become the most important primary and distributive market for flaxseed not only in the United States but in the entire world. For each of the past two years a quantity equal to about one-half of the total flaxseed crop grown in the United States has been received by rail and distributed by lake from that port. The bulk of the flaxseed received at Minneapolis and Chicago, although they also are distributive markets on a smaller scale, is shipped out in the shape of manufactured products. But the functions of the market at Duluth-Superior, where but one small linseed oil mill is located, are almost exclusively distributive. From that center the linseed oil mills at Buffalo, New York City, and Philadelphia, in short, the entire Eastern branch of this industry, derives practically its entire supplies. Under present conditions about 10 million bushels of flaxseed are annually transported across the lakes from Duluth-Superior to Buffalo; of this quantity about 4 million bushels ordinarily would be retained at Buffalo for the consumption of the local mills, 3 million consigned to the other Eastern oil-making centers, and the balance exported through the ports of New York and Boston. Distribution is also made from Duluth-Superior to other American and Canadian ports, according to the varying exigencies of the trade.

PRODUCTS FROM FLAXSEED AND THEIR USES.

The principal product derived from flaxseed by the process of manufacture is linseed oil. The residue after the extraction of the oil constitutes the only by-product, linseed oil cake, a valuable cattle food, which, when ground for feeding purposes, is known on the market as linseed oil meal. In the oil-making process there is practically no waste, and on an average for the entire country it is generally accepted by the crushers that a bushel of flaxseed (56 pounds) is converted by manufacture into $18\frac{3}{4}$ pounds of oil ($2\frac{1}{2}$ gallons), and $37\frac{1}{4}$ pounds of oil cake. Out of a crop like the exceptional one of 1902 (29 million bushels) there could, therefore, be manufactured, after deducting a couple of million bushels for the next year's seeding, about $67\frac{1}{2}$ million gallons of oil, and upward of 1,000 million pounds of oil cake. The actual manufacture of linseed oil in the United States, however, is subject to a somewhat rigid limitation, arising from the fact that for this product there is little foreign demand. Importing

nations, as a rule, import the raw material in the shape of flaxseed and make their own oil, and the foreign demand upon the United States amounts to only about 100,000 gallons a year. The quantity of flaxseed manufactured in this country is, therefore, in the long run, practically limited to the domestic demand for linseed oil. Exactly what the demand amounts to annually it is of course impossible to determine, but, considering the fact that the principal use of this oil is for paint, there can be no doubt that, as a result of the unprecedented prosperity of recent years, the consumption of linseed oil has greatly increased. During the crop years, 1895–1896 to 1900–1901, both inclusive, it seems that the average quantity of flaxseed annually manufactured in the United States amounted to about 15 million bushels, with a resultant average annual yield of about 37½ million gallons of oil, and 558,750,000 pounds of oil cake. During these five years, it should be noted, there was successively a gradual increase in the quantities manufactured, and the continuation of this tendency in the subsequent year, together with the exceptionally heavy supply of domestic seed available for oil extraction, leads to the somewhat general opinion in the trade that the quantity of flaxseed consumed in 1901–1902 by the linseed oil mills of the United States amounted to about 20 million bushels, and that the domestic demand for linseed oil now absorbs an output of about 50 million gallons. On this basis, assuming that 2 million bushels is at present annually required for seeding purposes, the total annual consumption of the flaxseed in the United States now amounts to about 22 million bushels; hence, out of a 29 million bushel crop, a surplus of about 7 million bushels would remain for export and for reserves. In this connection it is interesting to note that exports of flaxseed from the United States in the twelve months ended December 31, 1901, amounted to 3,563,162 bushels, and for the corresponding period in 1902 to 4,046,178 bushels, the great bulk of the exports from every crop being made in the three or four months following harvest.

Of the two products derived from flaxseed, linseed oil has a sphere of economic usefulness peculiarly its own. It has no uses as an illuminant, none as a lubricant; and, although small quantities fresh from the presses are utilized, curiously enough, as a cooking grease by an element of the foreign population in some of the large cities, commercially it is valueless as an edible oil. In fact, linseed oil is adapted to none of the industrial or edible uses to which other oils are ordinarily put, whether they be vegetable, animal, or mineral. But, possessing in an exceptional degree the property of absorbing oxygen upon exposure to the air, it is essentially a "drying" oil; and, compounded on the one hand with divers pigments and on the other with various gums, it finds a field of usefulness in the composition of paints and of varnish to the almost total exclusion of all other oils. Its monopoly of this field is so complete that it has no adulterants,

except those which detract greatly from its economic value, and no substitutes, excepting possibly the single competitor, corn oil. Linseed oil is also utilized to the practical exclusion of other oils in the manufacture of linoleum, oilcloth, oil silk, patent and enameled leather, and printers' ink. Probably 65 to 75 per cent of all linseed oil manufactured in the United States is compounded with pigments and gums and used as paint and varnish in the preservation and adornment of the wood and other substances that enter into manifold structural uses. The bulk of the remainder is utilized in the manufacture of linoleum and oilcloth. Among the minor uses to which this product is put, it has been stated upon good authority that probably a million gallons are consumed annually in the manufacture of printers' ink. Linseed oil is also used in the manufacture of waterproof fabrics not made of rubber, as an enamel for buttons made of wood pulp, in the manufacture of opaque window shades, for some few medicinal purposes, in the making of a soap especially valuable for washing woodwork, and for other minor purposes.

Linseed oil cake, the single by-product from the manufacture of linseed oil, is in very limited demand in the United States, but finds an extensive market abroad. This cake is used only as a cattle food, and forms one of that group of highly concentrated albuminoid or flesh-forming feeding stuffs, including cotton seed oil cake, corn oil cake, rape seed oil cake, compound and other cakes, so highly prized by European stock raisers, but little appreciated on this side of the Atlantic. To determine accurately the proportion of linseed oil cake retained in the United States for domestic consumption as compared to the proportion exported is not possible. But, assuming that 20 million bushels of flaxseed were crushed in this country in the crop year 1901–1902, the total production of linseed oil cake was about 745 million pounds; the exports for the fiscal year 1901–1902 were 582,886,775 pounds, indicating in a general way that about 78 per cent of the total output was sent abroad against only 22 per cent retained for home consumption. From the best available data obtainable for the two preceding years the proportion exported as compared to the total output shows no material difference, so that it is doubtless safe to assume that not much more than 20 per cent of the linseed oil cake manufactured in the United States is utilized as feed for domestic live stock. Almost 80 per cent of the total available supply of this valuable cattle food (exceptionally valuable from an economic point of view, both as a fattening food and because of the high fertilizing properties of the manurial residue) is shipped abroad and converted into milk and beef upon the dairy and stock farms of northern Europe.

The principal customer of the United States for linseed oil cake is Belgium, her takings having increased from 39,021,367 pounds in

1895 to 148,263,752 pounds in 1901. Of almost equal importance is Holland, whose imports of this product from the United States have increased from a quantity less than one-half those of Belgium in 1895 to 136,728,914 pounds in 1901. These two countries combined take annually upward of 60 per cent of the total exports of linseed oil cake from this country. In the United Kingdom, third in importance as a customer for this product, the use of American linseed oil cake seems to have been to a considerable extent supplanted by cotton seed oil cake. In 1895 the English demand upon the United States for linseed oil cake amounted to 168,717,198 pounds, and for the like product from cotton seed to 156,048,267 pounds, but since that date the demand for the linseed product has declined almost without interruption until in 1901 it amounted to only 98,368,610 pounds, while the demand for American cotton seed oil cake had increased in the same period to 312,409,282 pounds. The English people prefer for feeding purposes a cake containing a high percentage of oil; and to the fact that cotton seed oil cake better fulfills this requirement, and is also cheaper than linseed oil cake, is largely due this remarkable change in the character of this trade. The only other European customers for American linseed oil cake are France and Germany, whose combined takings, however, amount to only about 60 million pounds a year. From countries on this side of the Atlantic there is little demand for this product; the West Indies and Canada are practically the only importers, and their combined trade amounts to only about 10 million pounds annually. The average annual exports of linseed oil cake from the United States to all countries for the five years ended June 30, 1902, amounted to 488,891,125 pounds, and the average annual value of the trade was $5,665,392. The exceptionally heavy exports in the fiscal year 1901–1902 were valued at $7,508,133.

Practically all, both of the linseed oil cake and of the cotton seed oil cake exported from the United States to Europe, is taken by six countries, the United Kingdom, Denmark, Holland, Belgium, France, and Germany. And it is curious to note the almost inexplicable preferences shown by each for one or the other of these feeds. With the notable exception of Denmark all of these countries feed both cakes. But, divided on the basis of a larger importation from the United States of one or the other feed, Belgium, Holland, and France may be classed as the linseed oil cake importers, and Germany, the United Kingdom, and Denmark as importers of the cotton seed product. Belgium imports about three times as much linseed oil cake as cotton seed oil cake, Holland almost equal quantities of each, and France, though not an important taker of either, shows a preference for the linseed product. Germany, whose imports of linseed oil cake are on a small scale is, on the other hand, the largest consumer of cotton seed cake in Europe, and takes annually from the United

States a quantity almost equal to the total imports of American linseed oil cake by all Europe combined. The trend of the English trade in these products has already been noted. The trade with Denmark is anomalous; that country takes no linseed oil cake at all, but as a consumer of the cotton seed product ranks third among European countries, and imports annually from the United States from 250 million to 275 million pounds. An attempt to find some explanation of this peculiarity of the oil cake trade with Denmark resulted in the following letter from a prominent importer in Amsterdam:

The reason of so little American linseed cake going to Denmark is not, as you suppose, because of a greater importation of Russian linseed cake, but simply because of a smaller consumption of the article. I have on several occasions discussed the merits of linseed cake with large cattle holders of Denmark, but the discussion always ended in their maintaining their opinion that if cows be fed on linseed cake the butter obtained from their milk was invariably of less delicate flavor. For fattening purposes, however, they admitted linseed cake to be the feed par excellence, but here again importation was debarred by reason of its being so high-priced a commodity. This forces them to use large quantities of cheaper cotton seed meal and cotton seed cake instead. When I pointed out to them the unique reputation linseed cake enjoys in our country (Holland) as *the* feed for milk-giving cows, they nevertheless stuck to their opinion, stating it was the outcome of practical experience. How it is that linseed cake is held to yield an opposite result in Denmark from what it does in Holland is a riddle I can read as little as many others supposed to be solved by the laws of digestive economy as at present set forth. All I know is that there is no getting round such opinions, and they just have to be accepted nolens volens.

THE MANUFACTURE OF LINSEED OIL.

In extracting oil from flaxseed two processes are used, one known as the "old" or hydraulic-press process, and the other as the "new" or naphtha process. The old process is the one in general use in the United States, the new process being actively represented in 1902 by a single mill in South Chicago.

THE OLD PROCESS.

The distinctive feature of the old process, the process by which over nine-tenths of the oil manufactured in the United States is expressed from the seed, is the hydraulic press. In this system the press is the productive unit, and the capacity of a mill is universally estimated among the crushers by the number of presses it contains. Preparatory to the extraction of the oil by mechanical pressure, the flaxseed is crushed between high-speed steel rollers into a fine meal known as flaxseed meal. In some foreign countries this meal is used to some extent as a feed for calves. It is a frequent practice among dairymen who raise their own calves to add crushed flaxseed to skim or separated milk, regarding it as one of the safest and most economical substitutes for the abstracted milk fat. In this country flaxseed meal is known

popularly in a small way only for its medicinal use as a poultice, and has no other use outside the linseed oil mill. In the oil-making process this meal is heated in "heaters," reservoirs especially constructed for this purpose, either by injecting the steam directly into the meal as it flows in a steady stream from the rollers into the heaters, or by the use of steam-jacketed heaters where no free steam is admitted to the meal. The meal is then drawn from the heaters into cake formers, machines which compress it into a shape of just sufficient consistency to allow, by careful handling, of its being folded in a woolen cloth and placed in the press. Although the press is universally taken as a uniform productive unit, the presses in different mills may really vary in productive capacity according to the number of "plates" they contain, each plate, located one above the other in the press, simply representing a separate compartment for the reception and compression of the meal that has been put into proper shape by the cake former. These plates may range in number from 16 to 26 to the press, but since the usual and average number is about 20 plates to the press, it is obvious that the common custom of estimating capacity by presses answers all comprehensive purposes. The presses, massive pieces of machinery, are arranged in rows in "batteries" of either 5 or 6 presses each, and a force of 3 men is required for each battery. Beginning at one end of a battery the separate compartments of the first press are filled with the slightly compressed meal, powerful hydraulic pressure applied at once, and so on with each press of the battery in succession. The operation of emptying and filling each press requires about ten minutes, and hence it is apparent that in a battery of 6 presses each press is under pressure for an hour, the oil meanwhile flowing from the presses into tanks. At the expiration of that time the hydraulic pressure is taken off from the press first filled, the now hardened oil cakes removed from between the plates, the press refilled with meal and the other presses emptied and refilled in the same way in succession, and so on indefinitely. The oil is then forced through filter presses for the purpose of removing mucilaginous substances known as "foots," after which it is placed upon the markets as raw oil; or, after filtration, its drying properties may be increased by boiling and the simultaneous addition of litharge or other dryers, in which case it is known to commerce as boiled oil. Numerous brands of refined oil also result from various processes of refining. During the crushing season the mills as a rule never stop, the moderately high temperature at which it is desirable to keep the machinery and the atmosphere of the mills requiring their constant operation night and day, stoppages from various causes of course excepted.

THE NEW PROCESS.

The "new" process is a chemical one, the oil being extracted from the seed by the action of the volatile solvent, naphtha. As in the old process the productive unit is the hydraulic press, in this process the distinctive feature is the percolator, a huge iron tank with a capacity for holding about 1,000 bushels of seed. The only active mill using this process in the United States has 16 of these percolators in its equipment. The flaxseed, after having been crushed into meal exactly as in the old process, is dumped into the percolators and flooded with naphtha. The naphtha, having an affinity for the oil, extracts it from the meal, and after the requisite length of time there is drawn off through a valve in the bottom of the percolator a compound product of linseed oil and naphtha. The naphtha is then evaporated and condensed for further use, and there is left the commercial product, linseed oil. The by-product of the new process is obviously not oil cake, but oil meal, which is removed from the percolators after the compound product, oil and naphtha, has been drawn off. It is then dried, deodorized, and placed upon the domestic market as a cattle feed.

MAGNITUDE OF THE INDUSTRY

The operations of the linseed-oil industry of the United States can probably best be understood by considering the industry with reference to its productive unit, the hydraulic press. Not only the different capacities of the individual mills and the relative importance of the great oil producing centers, but also the magnitude of the industry as a whole can best be expressed, after the custom of crushers, in terms of presses. Presses in different mills, it should be remembered, vary somewhat in seed-consuming capacity according to differences in methods of operation, in the number of plates, etc. In a few mills the quantity of seed consumed per press per day ranges as high as 175 bushels. In some others it amounts to no more than 125 bushels. In most of the well-equipped mills, however, crushers generally claim to press 150 bushels per press per day of twenty-four hours. The most definite estimate probably that can be made as to the capacity of the press, viewing the industry as a whole, is that it is from 125 to 150 bushels per day. And since the average number of days that a mill can be economically operated in a year is generally regarded as about 250, the annual capacity of a press may therefore be put at from 32,250 to 37,500 bushels.

As measured by the number of presses, individual mills differ widely in capacity. The largest mill in the United States in 1902 was located in Buffalo and contained 90 presses. The arrangements which have been made for adding 48 presses to this plant will make it the largest mill, running on flaxseed alone, in the world. The second largest mill in the country operated 84 presses and was located

on Staten Island, New York. One 50-press mill was in operation in Buffalo and a 48-press mill in Chicago. Two mills of 40 presses each constituted the largest establishments of this class in the important Western oil-producing center, Minneapolis. As an illustration of the concentrative tendency of this industry, the above six mills, comprising in number only about one-seventh of the active mills in the United States, had a combined crushing capacity equivalent to almost one-half the active capacity of the entire country. The other mills ranged, as to the number of presses, from 24 presses down to 5, mills of 12 presses being the most common.

In linseed oil making, as in any other industry, the manufacturing capacity of the great producing centers can not be taken as synonymous with the actual industrial operations at those points. Crop failures, changes in transportation rates, the interests of individual manufacturers, and many other causes may incite temporary or even permanent activity at one point while tending to check business in the same lines at others. Probably not far from 70 per cent of the flaxseed crushed in the United States is ordinarily crushed at the four great linseed oil producing centers, Buffalo, Minneapolis, New York, and Chicago.

Estimated on the basis of the number of presses, Buffalo with a total of 157 presses is the leading crushing center of the United States, a supremacy which is to be further increased by 48 additional presses. In the city of Chicago the five mills operating the old process have a total of 95 presses; the new-process mill, being estimated as equivalent to 50 presses, raises the aggregate to 145. As, however, Chicago has declined as a primary market for flaxseed, so it has as a producer of linseed oil; and, ranked by its actual output of that product rather than by its productive capacity, it would stand nearer fourth than second among the great crushing centers. The great linseed oil producing center of the West is Minneapolis; and, although the five mills operating there in 1902 had a combined total of only 118 presses, or 39 less than the total in Buffalo, it is likely that in the long run the quantity of seed actually consumed at that point equals, if it does not surpass, the crush at Buffalo. Moreover, a new mill of 21 presses, which was in process of construction in Minneapolis at the close of the same year, will increase the crushing capacity of that point to 139 presses. The number of presses in the two mills in New York City in 1902 was 108, making the total for the four principal crushing centers of the United States 528 presses. These mills represented an annual crushing capacity of from 17 million to 19 million bushels of seed.

In the forty-odd linseed oil mills in operation in the United States in the fall of 1902, not including a few small, inactive mills, there were approximately 750 presses. Their combined crushing capacity, if operated 250 days in the year, would be from 24 million to 28 million

bushels, with a possible output of from 60 million to 70 million gallons of oil. Since the domestic demand for oil does not exceed 50 million gallons a year and the foreign demand is unimportant, it is evident that the crushing capacity of the country is at the least 4 million bushels in excess of the country's requirements. This surplus capacity is naturally reflected in the operations of the industry. All the mills are not run steadily throughout the crushing season, and gluts in the oil market are obviated to a degree by shutting down some of the sources of supply.

USE OF MINERAL OIL IN ROAD IMPROVEMENT.

By James W. Abbott,
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INTRODUCTION.

Public attention was first called to the utility of crude petroleum oil in road betterment through experiments made by the county of Los Angeles in California in 1898, where 6 miles of road were oiled in that year under the direction of the supervisors. The sole purpose of this work was to lay the dust, which, churned beneath the wheels of yearly increasing travel during the long dry seasons in that region, had become a most serious nuisance.

The following year this mileage was a little more than doubled in that county, and other counties in California also began experiments along the same line.

From the very first the results obtained were so astonishingly successful that the practice rapidly increased. It spread through every county in southern California, and then began to work north. Now, after five seasons, it has extended from near the Mexican line, on the south, to Durham, in Butte County, on the north, a stretch covering sections of quite widely differing climatic conditions, with an aggregate of about 750 miles of county roads and city streets oiled for one or more years. Oil has been used on the principal driveways of Golden Gate Park, San Francisco. The mountain stage road into the Yosemite National Park has been oiled for a distance of 30 miles, from its initial terminus at Raymond to 8 miles above Wawona.

In California it has now passed the experimenal stage. More than 25 counties in that State have already used it, and others are preparing to do so during the season of 1903.

Thus far California is the only State which has actually adopted the practice. It has been tried to a very limited extent in Texas, and a few isolated experiments have been made in Pennsylvania, New Jersey, Indiana, Colorado, and the District of Columbia. Within

the past year also a few experiments have been reported from England, France, and Switzerland.

ORIGINAL OBJECT OF USE OF OIL ON ROADS.

As already stated, the original motive for the use of crude oil on roads was to lay the dust. Wherever oil has been tried this purpose has invariably been accomplished, regardless of methods adopted or variety of oil used. On all kinds of roads where it has been applied the dust has ceased absolutely for at least an entire season after its application, and if renewed a second year has been abated for that year also and the following, whether then treated or not. In southern California all unite in saying that the great bane of life—dust—passed away wherever the first application of oil was made. The dust raised by passing travel no longer comes in at windows or destroys the products of field and orchard for considerable widths on each side of the road, as it formerly did. The report of its effectiveness as a dust layer is just as positive and enthusiastic from all sections which have made the experiments.

BENEFITS FROM THE USE OF OIL ON ROADS.

In California it was soon learned that, incalculably valuable as it was, the laying of dust was not the only or even the most extraordinary result obtained. It was found that when oil was applied it immediately began to bind together all the loose particles constituting the road surface, whether clay, sandy loam, loose sand, gravel, or the fine material on the top of macadam. A tough stratum formed, resembling an asphalt pavement. Roads built on drifting sand or clayey dust, no matter how deep, where trotting with a buggy was impossible and for a pair of strong horses to pull a ton was a very laborious process, became indurated, resilient, and firm, so that driving teams could trot with ease and the same pair of horses pull 2½ tons more comfortably than they formerly did the 1 ton. Of course, these results were not fully obtained immediately, but they never failed to follow persistent treatment with oil.

At first, while this oiled surface stratum was thin, it was often broken through, especially in wet weather, but proper repairs and subsequent applications of oil thickened and strengthened it until it would at all times effectually withstand the heaviest and most continuous travel. (Pl. LIV and Pl. LV, fig. 1).

Running south from the railroad track in the town of Chino, San Bernardino County, Cal., is a piece of road over which every season nearly 40,000 tons of sugar beets are hauled on their way to the factory, often averaging 750 tons a day. The foundation of this road is a loose sand, and it has been surfaced with a material containing some clay. Formerly the loaded wagons often stalled and had to be

FIG. 1.—ROAD IN EVERGREEN CEMETERY, LOS ANGELES, CAL., NATURAL STATE.

FIG. 2.—ROAD IN EVERGREEN CEMETERY, LOS ANGELES, CAL., OIL SURFACE NEWLY FINISHED.

dug out. Now, after three seasons of treatment with oil, the road is as easy to drive over as a good city street, and effectually sustains the heavy travel, although the majority of the wagons used on it have narrow tires. The benefits of the oil were experienced immediately after the first application was made, but the surface stratum under successive treatments grew thicker and firmer until the road has become virtually perfect.

In another place in the same county, several miles distant from the one just described, the road runs over drifting sand just like the worst to be found on Cape Cod, in Massachusetts. (Pl. LVI.) It has been treated for two seasons with oil, and is now equally as good as the other. Both pieces of road were visited and carefully examined by the writer, who can testify to the almost incredibly satisfactory results obtained.

TESTS OF OILED ROAD SURFACES BY SEVERE RAINFALLS.

All semiarid regions are subject to very heavy rainfalls at times, which are generally called waterspouts. In California these have in many places subjected oiled road surfaces to the severest possible tests. Mr. Theo. F. White, a civil engineer, one of the supervisors of San Bernardino County, a man who has had a great deal of experience in oiled roads and made them a special study, tells of one storm occurring in that county in which $10\frac{1}{2}$ inches of rain fell, 6 inches of it in a single night. He says:

> The whole country was flooded and it gave us a good test of our oiled roads. There is a road running into San Bernardino on a grade of about 6 per cent. about 300 or 400 feet from a bench down into a creek bottom. The road had been oiled a second season and there was a good oiled surface. The water rushed down the middle of that road, because the ditches could not carry such a great volume of it, and it did not make a scratch on the road, but a half mile south there was a road of about the same grade which was so badly washed that it could not be used until it was repaired—a road that was not oiled. Between Pomona and Freeman there was a great quantity of water came from a canyon and struck the oiled road at right angles at one point. It came from the west, and on the east side of that road there was a margin of 6 or 8 inches of the surfacing material that the oil had not touched. The rain passed over the oiled surface, and when it came to that which was not oiled it cut it right out. Upon the same road within the city limits of Pomona the road was surfaced with decomposed granite, packed down hard, and a very nice road during the summer, but it had not been oiled. The same storm cut it all to pieces. On one stretch of a quarter of a mile the road material was fairly washed out into the fields alongside the road.

SOME THEORETICAL OBJECTIONS TO USE OF OIL ON ROADS.

When they first began to use oil on roads in California there was much speculation as to whether it would not be found objectionable; but when properly applied, and suitable precautions were taken not to use the road before it was ready, the theoretical objections vanished. When oil was placed upon the surface of the road, if vehicles

were allowed to run over it before it had sunk in and become thoroughly incorporated with the road material the wheels picked up the oil and threw it in all directions, injuring clothing and everything else of a delicate nature upon which it fell. After experience had taught how to avoid this, no further serious difficulties manifested themselves.

There does not appear to be such a thing as dust from an oiled road. Of course, dust from outside may blow onto an oiled road, but this soon adheres to the oiled surface and ceases to rise.

To determine whether oiled road material would produce a stain the writer repeatedly scraped up some from the surface of a road which had been treated some months before and placed it in a clean white handkerchief. Taking the corners of the handkerchief in the left hand, the ball of dirt was turned by the right hand, so as to compress the contents as the housewife does her fruit pulp when making jelly. After turning until the compression was carried as far as the strength of the handkerchief would permit, the ball was manipulated by the right hand for a moment or two. Then retaining one corner of the handkerchief in the left hand, the others were dropped and the handkerchief thoroughly shaken. None of the material adhered to the handkerchief and no discoloration could be detected.

The mud from oil-treated roads, after the oil has become thoroughly diffused through the material, does not appear to be more objectionable than ordinary mud.

Diligent inquiries about the effect of oiled roads on rubber tires failed to disclose any complaints, except in cases where the tire had come in direct contact with the oil. So far from being injurious, the claim is made by some that the resiliency of an oiled road surface and the protection against the sharp edges of sand and gravel increase the life of rubber tires very materially.

It has not been uncommon for asphalt pavements in cities to become softened by the heat of the sun to such a degree as to be injured by the wheels of heavily loaded wagons. No difficulty of this character is ever experienced with the surface of an oiled road.

For a short time after oil is applied there is a very perceptible odor, which soon disappears almost entirely. While it lasts it is not essentially disagreeable, and many people rather like it.

An incidental advantage of oil on roads is the help to the eyes. The reflection of the sun from white road surfaces and the dust blown into the eyes are both very trying to the eyesight. Oiling gives the road a seal-brown color.

In California oil is found to be very effective in preserving the planking of wooden bridges. A liberal coat is first given to the wooden floor, and upon this is spread a layer of sand about 1 inch deep. A very light sprinkling of oil is then given to the sand, which binds together and forms a layer that is not only waterproof, but

protects the wooden surface from direct contact with the wheels of vehicles.

The growth of oil in popular favor in southern California has been steady and rapid Many of those who have had most experience with it have come to regard its use in a dry region as the most important discovery ever made in road making. Quite a considerable number of people have said to the writer, "We could not go back to the old conditions; if we had to give up our oiled roads we would move away."

VARIETY IN COMPOSITION OF CRUDE PETROLEUM OILS.

The chemical composition and character of crude petroleum oils vary greatly in the different localities where the oils are found. They are all complex hydrocarbon compounds. The more carbon they contain the greater their specific gravity and the higher the temperature required to evaporate them. The petroleums of Russia belong generally to what is known as the naphthene series. Those of Pennsylvania, Ohio, Colorado, and Wyoming have a paraffin base, and those of California and Texas have an asphalt base. The specific gravity of an oil is expressed in degrees Baumé.[a]

All petroleums will lay dust, but asphalt is required to bind together the loose particles of a road surface. As soon as petroleum is put on a road all the lighter hydrocarbons which it contains begin to evaporate whenever the temperature is reached at which they vaporize. After a time nothing but the heavier ones remain. Properly speaking, asphalt is a solid, and maltha is the more correct name for the liquid, which is actually asphalt dissolved in lighter hydrocarbons. But in practice it is customary to designate as asphalts all the heavy liquids derived from natural deposits, which are composed of hydrogen and carbon.

Asphalt is itself a compound, its principal constituents being petrolene and asphaltene. Asphaltene is a solid, and extremely brittle. Petrolene is a thick, black, viscous liquid, which volatilizes only when it reaches a temperature of 450° F., and therefore remains stable under all atmospheric conditions. We do not know just what

[a] Baumé was the name of a man who devised an apparatus for determining the specific gravity of liquids. This apparatus for liquids lighter than water consists of a hollow glass stem with a bulb blown in the middle so as to insure buoyancy, and another bulb in the bottom to hold mercury, like the bulb of a thermometer. A short distance above the upper bulb Baumé made a mark and then poured sufficient mercury into the lower bulb so that the apparatus would sink in a 10 per cent solution of salt and water to that mark. The apparatus (called a hydrometer) was then immersed in pure water, which is much lighter than salt and water, and of course the hydrometer sank deeper. The point to which the stem sank in the water was carefully marked. The distance between these two marks was graduated into ten parts, called degrees, the bottom zero, the upper one 10. Water is therefore 10 degrees Baumé, written "°B. 10" or "10° B."

is the separate effect of the dissolved asphaltene and petrolene, but we do know that the asphalts which contain them bind the loose particles of the road surface together into such a crust as has been already described.

In the California asphalts the asphaltene and petrolene are found combined in very variable proportions. In the petroleums which contain them the combinations of all the hydrocarbons differ, not only in the same immediate oil field, but in the separate strata and even in the same stratum.

The very heaviest of the oils have almost the specific gravity of water, while a naphtha may be 75° B., or even lighter.

From the very beginning of the use of crude oil for roads in California it seems to have been understood that it was the asphalt in the oil which acted as the binder, and consequently they have always sought very heavy oils for that purpose. It might naturally be supposed that the heavier the oil the greater the percentage of asphalt. While this is approximately true, it does not necessarily follow. A crude oil is a complex mixture of light and heavy hydrocarbons, and its resultant gravity depends upon the amount of each kind which it contains.

The following was compiled from the notes of eleven analyses of crude oils made in California by D. B. W. Alexander, now the Denver chemist of the Colorado Paving Company. The original determinations covered many other data, but in the table only the degrees Baumé and the percentage of asphalt are shown:

Analyses of crude oils.

°B.	Per cent asphalt.	°B.	Per cent asphalt.
10.4	64.1	15.7	39.9
12.2	45	19	28
13	61	19.3	32.8
13.75	59	23	25.4
15.4	32.1	23	43
15.5	50.2		

All of these oils doubtless contained a small amount of mineral matter which affected the specific gravity and disturbed the relation between it and the asphalt contained.

The above table shows that in selecting a petroleum for road purposes the specific gravity alone is not a sure guide. It also shows that the California practice of selecting an oil of 12° B. to 14° B. can be depended upon for good results.

Mr. L. B. De Camp, of San Francisco, suggests the following as a crude test used by him; it is probably closer than the Baumé measurement:

Pour a definite amount of crude petroleum into a graduated glass and add an equal amount of refined petroleum. Stir thoroughly together and add to the mixture 2 per cent of commercial sulphuric acid. Again stir thoroughly and the

asphalt will precipitate to the bottom. The percentage which it represents of the original amount of oil can be measured by the graduations on the glass.

THE OILS USED ON ROADS.

Instead of crude oil, asphalt residuums, from which the lighter products have been distilled, have been much used on roads in California, but no observations have been made to determine whether the results have been more satisfactory in proportion to the amounts used.

Texas oils carry on an average a much lighter percentage of asphalts than California oils.

In the few experiments made with oils on roads in the United States outside of California and Texas a residuum from paraffin crude oils has generally been used of about 26° B. While these experiments have always been successful in laying dust, they have not been followed up with sufficient persistency to demonstrate any efficacy of this material as a road maker. It is known that many of the hydrocarbons will under certain conditions form a chemical union with oxygen and nitrogen, producing a small percentage of asphalt. It is possible that if roads were repeatedly sprinkled with any crude oil it might be found in time that the oxygen and nitrogen of the atmosphere had united with them and produced some asphalt of enduring value to the road.

The European experiments were made upon macadamized roads and were designed solely with a view to laying the dust. In England they used a crude petroleum from Texas and on the Continent Russian oils.

METHODS OF APPLYING OIL TO ROADS.

Without precedent anywhere for a guide, naturally the first experiments along this line were tentative and differed in method, according to the theories and ingenuity of those intrusted with their execution. For a time it was quite strenuously argued by many that it was the better practice to apply the oil to a road surface while it was moist like an orchard soil, when it works well. It was contended that the water and the lighter oils evaporating together would effect a more desirable result than could be secured without water. This view is now unanimously rejected by all experts in road oiling. While all agree in advocating liberal sprinkling in preparing the road surface, the aim is to let the water all evaporate before the oil is applied.

HEATING OF OIL FOR ROADS.

There has been a very spirited controversy over the question, "Must oil be artificially heated to produce the best results?" Until within the past year the majority of the practical oiled road makers insisted that it must; but experience with oil at normal temperature (always spoken of as "cold oil") has resulted in increasing the number of those who advocate doing away with heating devices. It is universally conceded that the hotter the oil can be applied the more quickly it

becomes absorbed and incorporated with the road material. Heat thins the oil and increases its tendency to penetrate a firm road covering.

The principal argument against heating is its cost. It requires special apparatus, and the process involves some expense. If the heating apparatus is stationary, the oil must go to it to be heated and hauled from it onto the road treated, no matter how far away.

These stationary heating plants have always been erected at some railroad siding. If possible a siding has been selected above the general surface. A receiving tank, large enough to hold the contents of one tank car, was placed beside the track, low enough so that oil from the car would all run into it by gravity. A heating tank was then placed above the receiving tank, and at sufficient elevation so that the heated oil would run by gravity into the distributing tank wagons. A stationary boiler was installed to force steam at high pressure through steam coils in the heating tank, from which the steam exhausted into a feed-water tank. A pump to raise oil from the receiving tank to the heating tank, a feed pump, and a structure to house everything in, completed the installation. The first cost of such a plant was between $1,000 and $1,500.

At Golden Gate Park, in San Francisco, Superintendent John McLaren uses two distributing tank wagons of 650 gallons each, which are both equipped with steam coils, so that the oil in one can be heated while the other is distributing. Steam from the boiler at the pumping station is used. Of course, this necessitates hauling the oil to this point to be heated. In some places a portable traction engine has been used. This, with coils in the distributing tanks, allows the oil to be delivered by the cars at the siding nearest where the work is being done, and reduces the heating cost to a minimum. But the tendency in oiled-road practice is toward relying for heat upon the sun only.

PREPARATION OF THE ROAD.

When a road is to be treated it must first be prepared to receive the oil. It should receive a crown of about a half inch to the foot; on a 16-foot roadway this would leave each side 4 inches lower than the center. Careful attention should be given to the drainage, so that water can quickly run off and not soak into the foundation of the road from the sides. The oil covering when finally made will be impervious to water, but if the foundation is water soaked it loses its firmness and ability to support the road surface under travel, and causes it to break through in spots.

After the road has been properly shaped it should be given a thorough soaking with a road sprinkler and rolled with a light roller. The purpose of this is to insure uniform consistency and a firm foundation. It should then be left undisturbed, if possible, until the water dries out. Many roads have been oiled and excellent results

obtained without any wetting or rolling, but the practice described is the best where the facilities are obtainable.

A soil which after being wet tends under travel to pack firmly, but is still sufficiently porous to let water drain through, is ideal for treatment with oil. A clay that bakes and then pulverizes into fine dust under the wheels will only give good results when some material is added, as explained later.

After the road surface has become dry it is well, if feasible, to run a sharp-toothed harrow over it, so as to loosen it to a depth of 3 inches. The aim is to secure an oil crust 3 inches thick. If the road surface can be made to absorb oil to that depth, that is the simplest way to get the crust. If this surface is hard and will not readily yield to the harrow for a depth of 3 inches, the practice is to build it up by adding material after the oil is applied.

MACHINES FOR DISTRIBUTING OIL ON ROADS.

The next process is the putting on of the oil. If travel can be kept entirely off the road, then the full width should be finished

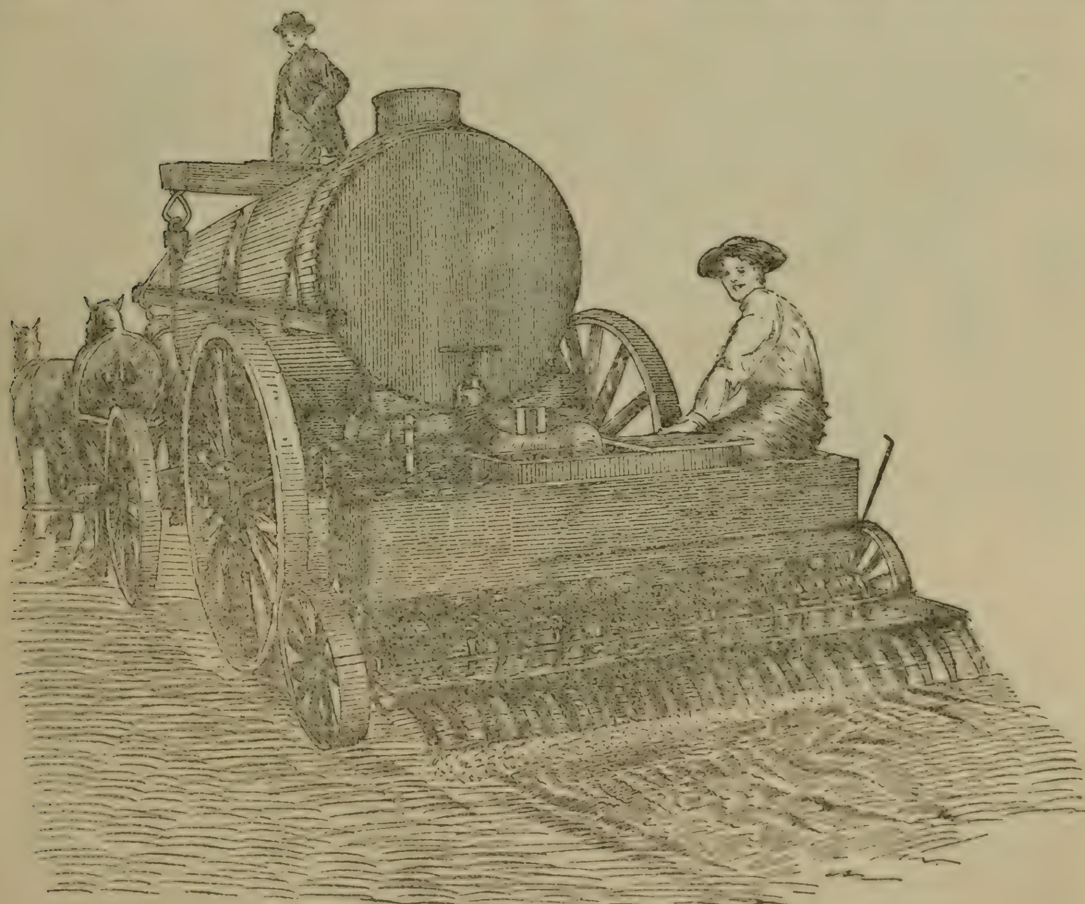

FIG. 39.—A road oiler.

before vehicles are allowed on it. If that is impossible, then a strip at a time must be treated, and travel meanwhile confined to the other strip.

The oil is put on by means of a longitudinal tank mounted on wheels like an ordinary sprinkling wagon. Four horses can readily pull one holding from 800 to 1,000 gallons. To the rear of this tank is attached the device which lets the oil out onto the road. Attempts have been made to use an ordinary sprinkling wagon, but with very poor success. It has been found impossible to get any regulation to the discharge. When the tank was full it would discharge much faster than when it was partly full. There was a tendency also for the center of the strip treated to get too much oil and the edges not enough. If hot oil was used, the spray tended to cool it before it reached the ground.

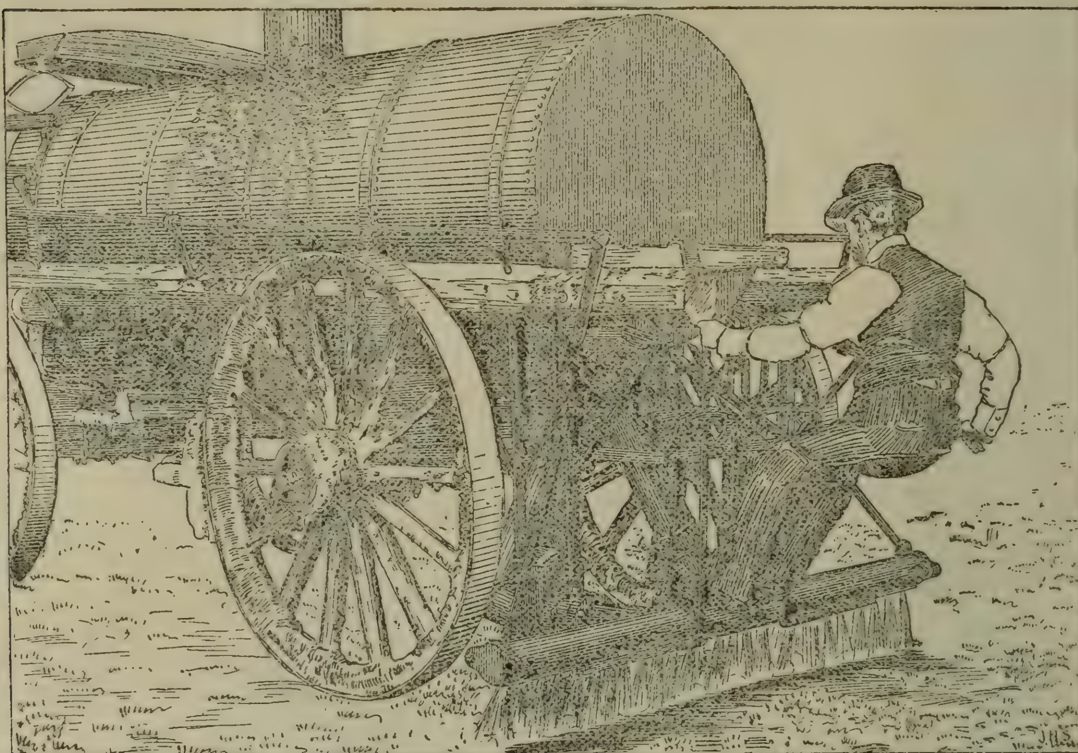

FIG. 40.—A second type of road oiler.

In what is known as the De Camp machine (fig. 39) the distributer proper is mounted on separate wheels and coupled to the rear of the tank wagon, the slip tongue being removed. The oil runs from the tank through a flexible hose. It has an oil reservoir and three sets of fingers. The first set makes furrows just ahead of the oil-discharging pipes. The second set of fingers (or curved teeth) covers up the oil, and the third set stirs up the combination of oil and dirt. There is also a drag to crush any globules or chunks which may tend to form. When the oil is being distributed the second and third sets of fingers and the drag are raised from the ground by hooks. After the oil is distributed this machine is detached from the tank, the slip tongue put in, and the machine dragged back and forth over the oiled road until the oil has been thoroughly incorporated with the road material.

In other distributers, like the White (fig. 40) and the Glover (fig. 41), the oil is conducted from the tank by a forked tube into a large-bore pipe about 6 feet long, so attached to the framework of the wagon that it hangs crosswise of it and about 6 inches above the ground, just behind the rear wheels. This pipe has a number of openings on its underside through which oil can run out. These openings are uniform distances apart, in sets, and all controlled by valves which can be opened either by the driver or by a man who has a seat for the purpose on the rear of the tank. The various levers, cranks, connections, and fittings in all the machines are such as experience has

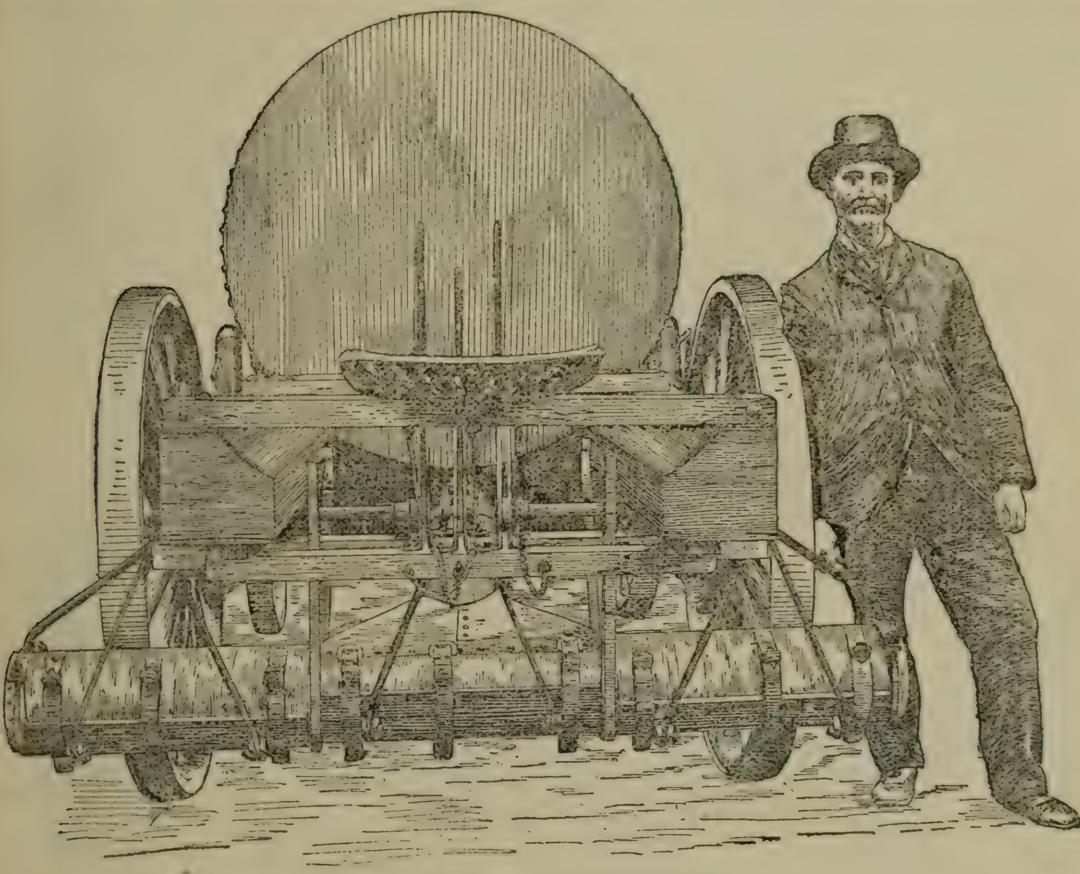

FIG. 41.—A third type of road oiler.

suggested, and the machines have been evolved by degrees. By having the openings in sets any width strip can be oiled which is a multiple of 18 inches.

Whatever form of distributer is used the driver starts his team on a walk, the valves are opened, and the oil, running through openings so close together, reaches the ground in a sheet practically unbroken for the width treated. The aim is to regulate the flow so as to spread all the oil the ground will absorb.

The next process is to stir up the newly oiled surface and work the oil and road material together. How this is done with the De Camp machine has already been described. Other ways are as follows: A

sharp-toothed harrow, preferably the ordinary steel-lever kind, with the teeth slanted back, is dragged along and then across the road until further stirring is unnecessary. In Golden Gate Park men follow the distributer with rakes and stir the material entirely by hand. Special machines called "stirrers," to be drawn by horses, are made, in which the teeth have an oscillating or cross motion when the machine is being pulled forward. Another machine, which is said to be especially valuable when the ground is cold or wet, is the Fitzgerald roller, provided with alternating rows of inch-square steel prongs 6 inches long.

If after the stirring process some spots appear sticky and others dusty, it shows too much or not enough oil. Over the sticky places

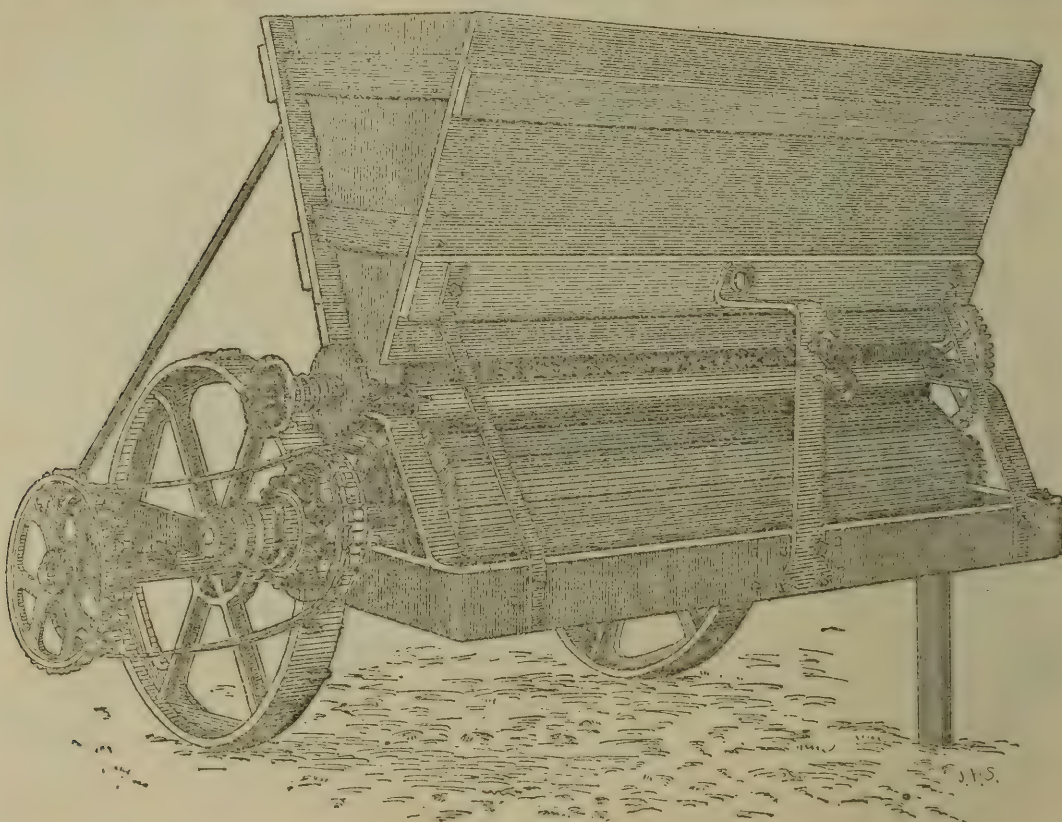

FIG. 42.—A sanding machine.

should be thrown some of the unoiled road material and this stirred in with a hand rake. The dusty spots must be treated with more oil and stirred. The whole work should show uniform results.

After twenty-four or forty-eight hours the road can be traveled over.

SANDING THE ROAD.

The practice above described is that followed when the road material is sufficiently porous for oil to readily mix with it. If it is hard, like baked clay or macadam, and can not be readily stirred, the practice is very different. For such conditions the oil must be put on when the road surface has been heated as much as possible by

FIG. 1.—ROAD THROUGH DEEP SAND, CHINO, SAN BERNARDINO COUNTY, CAL.

FIG. 2.—SAME ROAD SHOWN IN FIG. 1; AFTER OILING HAS HARD, SMOOTH CRUST.

the sun. If the oil itself can be first heated, so much the better. In fact, the more heat there is in the oil, the ground, and the atmosphere when oil is applied, the quicker the results obtained, whatever process is used. Some of the oil will sink into the hard covering; the rest will remain upon the surface and must receive a coating of sand or fine gravel. The oiled crust which results from such treatment will be partially the top surface of the original road and partially the new envelope. This can be still further built up by another oiling and another layer of sand. This sand (or fine gravel or quite sandy loam) can be applied with a shovel by a man who rides on a load of sand driven beside the oiled strip. Practice will bring considerable dexterity in throwing out sand in thin strips with a shovel.

The White sanding machine (fig. 42) is a device for spreading the sand more uniformly. It consists essentially of a hopper and a corrugated drum mounted on an axle on two wheels and with a castor wheel in front. The sand falls onto the drum and runs out in a sheet whose thickness is regulated by appropriate mechanism. In practice, it is attached by a sort of triangular bracket to a wagon loaded with sand, carrying two men facing each other, who shovel the sand into the hopper. The wagon runs beside the oiled strip. The hopper runs on the sheet of sand which has fallen from it. When the wagon is empty, it is disconnected from the machine and replaced by a loaded wagon.

Some macadam roads in California which have been treated in this way are conspicuously excellent.

After an oiled road has been traveled a few weeks it is an advantage to roll it with a light roller; but the best rolling effect is obtained if as soon as travel begins on the newly oiled road a wagon is used with broad tires (at least 6 inches), with front axle shorter than the rear by an amount nearly equal to double the width of the tire.

QUANTITY OF OIL REQUIRED.

In California, where the aim is to always use an oil containing as much asphalt as possible, the amount of oil required for a 16-foot roadway varies between 250 and 400 barrels of 42 gallons each to the mile. This depends upon the thickness of the oil crust made, the porosity of the material, and the percentage of asphalt in the oil.

The quicker this oil crust is made the better. If two applications are made to a porous material and the oil properly stirred in each time, the crust will be finished. If the hard material is a clay, it should have at least two treatments. One will be sufficient for macadam. A dusty clay will require some gravel added for the first application. On the second application the crust which has begun to form should not be disturbed, but after all the oil sinks in that will a layer of sand should be sprinkled on top. In this oiled crust the bottom will be made from the clay dust and the top mostly from the added sand, while the middle will be a mixture of the two.

In the first experiments a part of the oil was generally put on the first year, and the crust was completed the second or third year. The first year the thin crust was often broken through and a hole was left in the road.

After the oiled crust has once been properly formed all the oil required will not exceed 25 barrels to the mile for repairs in each subsequent year.

Pl. LV, fig. 2, shows oiled crusts taken from three oiled roads in Chino, San Bernardino County, Cal., where a different practice was followed in each case. In all the substratum was a loose, sandy loam, sand predominating. All the roads were formerly very dusty, loose, and full of "chuck holes" in the dry season, making the hauling of heavy loads extremely difficult and driving disagreeable. The sandy substratum, as shown in the blocks, has become compacted under the firm oiled crust. Designating the roads by the numbers of the samples, No. 1 was surfaced with a clayey gravel, which always binds well. It was first treated in the summer of 1899, and subsequently in 1900 and 1901, but not at all in 1902. The amounts of oil applied were 120 barrels the first year, 80 barrels the second, and 40 barrels the third. The width treated was a little in excess of 16 feet. The crust is a little over 1 inch thick. In No. 2 the oil was applied directly to the loose roadbed, without any expectation of benefit except to lay the dust. It was oiled the same years as No. 1, with 100 barrels, 120 barrels, and 80 barrels, respectively. It began to compact the second season, and since the third season has averaged about 2 inches thick. It is an excellent, firm road. No. 3 was formed during the season of 1902, with two oilings of 150 and 100 barrels, applied at an interval of about eight weeks. It will average somewhat over 2 inches in thickness, and is the best road of the three.

REPAIRS TO OILED ROADS.

With an oiled road, as with macadam or any other kind, it is the constant vigilance and the stitch in time that accomplishes the best results in maintenance. It requires persistent attention. If the crust gets broken it should be repaired at once. For winter repairs it is well to mix in the fall a lot of sharp sand or fine gravel with oil, stirring it all up with a hoe in a mortar box as mortar is mixed, and being careful not to put on so much oil that any will run away when the mixture is left standing. When a hole starts, clean it out thoroughly with a hoe or brush broom, fill the hole to a little above the adjoining surface with some of the oil and sand mixture, and thoroughly ram it.

Most of the distributers which are now made have a short hose attachment, with gate and nozzle and shut-off valve for use in repairs. When a patch appears to have too little oil, or a hole needs repairs

and no oil mixture is at hand, a little oil can with this hose be put just where most needed, and with a rake, hoe, shovel, and rammer the difficulty is quickly remedied. In making repairs when fresh material is required, care should be exercised not to use any which has been subjected to travel and has refuse in it.

It frequently happens that travel follows the same track, and the narrow tires and feet of the horses wear depressions. It is important to correct these and reshape the road at least once a year. It has been found that an ordinary blade road grader will not do this successfully, but will tear up the oiled crust and destroy it. The White smoother is a device for shaving off elevations and filling up depressions in an oiled crust. It consists of a pair of runners 16 feet long and 4 feet apart. Between them, at the front end, are set on a slant backward obliquely to the left three rows of three-quarter-inch steel harrow teeth, so adjusted that they shave along lines just 1 inch apart. As their edges get dull the teeth can receive a quarter or half turn and their height from the ground can be regulated. There is also a blade set obliquely which scrapes off the shavings made by the harrow teeth. These shavings, confined by the two runners and the blade, naturally seek the depressions. In the left-hand runner is an opening, through which any surplus shavings are forced out toward the center of the road, thus tending to raise the crown. There are wheels on the sides upon which the machine, with runners raised from the ground, travels when being moved from one place to another, and a steering gear by means of which the operator readily controls its direction. A road reshaped with this machine, treated with a light sprinkling of oil and a thin sheet of sand and rolled, resembles a city asphalt street when first laid.

CONCLUSION.

The question will naturally be asked, "Where can oiled roads be made to advantage outside of California and Texas?" The answer certainly must be, Any place in the United States where, through long, hot, dry summers the roads become very dusty and where water can be kept out of their foundations in the winter, so that they will remain firm and not give way beneath the oiled surface in the spring. The reliance must be upon an oil with an asphalt base, whether it comes from California or Texas or is made by dissolving an asphalt in the crude oil of any section, all of them being solvents for asphalt. The gilsonites of Utah and Colorado, the asphalt deposits of Indiana, Arkansas, Indian Territory, and probably other localities, will all doubtless yield a product that can be combined with the paraffin crude petroleums for road purposes. The cost will of course be much higher than in California, where they have been accustomed to buy their heavy oils for a dollar a barrel and sometimes cheaper, but compared with the cost of stone-covered roads it will be found to be less

and in a very dry climate the results fully as good. Where the purpose is only to mitigate the dust any crude oil or its residuum will be found efficacious.

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SELECTING AND JUDGING HORSES FOR MARKET AND BREEDING PURPOSES.

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INTRODUCTION.

Perhaps in no other one line of work has there been such a lack of systematic study among farmers in America and in the practical application of known principles as in horse breeding. Farmers throughout the entire country have practiced haphazard methods of breeding for many years. They simply bred and reared horses without any regard whatever to the demands of the consumer. There is but one outcome to any business which is carried on without any definite purpose or object in view. Sooner or later a crisis will come. During the years of 1893 to 1896, inclusive, the farmers of this country were taught a valuable lesson pertaining to the advisability of breeding horses at random. Nearly every farmer in this country had unsalable horses on his farm—horses that while sound, or practically so (good, useful animals for certain purposes), at the same time were of no class, and which could not be sold even at very low figures. As a result of this depression farmers came to the conclusion that the horse market was gone forever, and they quit breeding and disposed of their surplus stock by selling at low figures, giving away or destroying their horses, in fact anything to get rid of them. In a few years these same men were in the market as horse buyers, when horses were very scarce and hard to secure even at very high prices. A reaction has taken place and the farmers are once more breeding horses, the majority of them in the same old way. If the present methods of horse breeding are not changed, history will surely repeat itself. Farmers should profit by past mistakes and aim to produce horses for a definite purpose. They should cater to the demands of the consumer, who will take care of the surplus horses. If one but looks back and studies the market he will be convinced that there never was a time, even when the depression was at its worst, when a good individual of any of the recognized classes would not fetch a fair price, and the time is far distant, if it ever comes, when such will not be the case.

Horse breeding, when judiciously carried on, has always been and is likely to be a reasonably profitable business for the American

farmer. The great danger in the business is that at the present time, when, owing to the fact that horses are scarce, the horse of no particular breeding or class is commanding a fair price, and many farmers are led to regard a horse of this kind as a profitable animal to produce. Such horses should not be bred, because even when the greatest care and precaution possible are taken in breeding for definite types there will always be a large number of the so-called misfits, which are the first class of horses to be affected by overproduction or any other thing that is likely to cause a depression in the market.

If horses are bred with a definite object in view the breeder will not be seriously affected by overproduction. There has always been and there always will be a fair demand for any of the recognized market types of horses. One of the greatest evils in the horse-breeding business is the patronage of the impure-bred sire, whose services can be had at a low fee. Nothing but pure-bred sires *of the very highest quality* should be used. There are even many pure-bred sires which should never be used for breeding purposes. Just so long as farmers will patronize inferior animals there will be plenty of them in use. Just so soon as farmers reject them there will be a noticeable difference in the number of inferior horses imported from other countries and kept in this country for breeding purposes.

To be a successful breeder of horses the following points are very essential: A man must be perfectly familiar with the horse markets—he must have a thorough knowledge of the various market classes, and know just exactly what constitutes each class. Then he must decide which of those classes is best suited to his tastes and his environments, as some men are competent to produce one class of horses, for instance, the draft horse, successfully, while they might make a total failure in producing some other class, such as the coach horse. Probably the most important requisite is that the breeder be a good judge of a horse; he must understand the proper conformation, action, and characteristics of the horse he is trying to produce, and the greater his knowledge of the internal structure, as bones, muscles, ligaments, nervous system, etc., the better. He must have a clear and well-defined ideal of the type of horse he is going to breed, and then set out with a determination to produce the same. He must not expect that every horse he raises will be of just the type he desires; at best he will be a most fortunate man if 50 per cent approach his ideal. There will always be some misfits—horses which do not belong to any distinct market classes.

Classes of Horses which can be Profitably Produced.

Under existing conditions there are at least four distinct classes of horses which most farmers can profitably produce. The first and most important is the heavy draft horse, next the carriage, or coach,

horse, the roadster horse, and the saddle horse. There is a market for other classes of horses at the present time, but none of them command very high prices, and most of them are the misfits which are bound to appear from time to time in the effort to produce horses of the first four classes mentioned. Such horses as "chunks," "trammers," and "bussers" are in reality undersized draft horses, and are the result of using a draft stallion on mares weighing from 1,200 to 1,500 pounds.

THE HEAVY DRAFT HORSE.

The heavy draft horse is one of the most profitable classes of horses that the farmer can breed. The draft colt can be reared with less risk and liability to accident than those of the lighter classes. This is partially due to the fact that the draft-bred colt is usually a quieter animal than those of the lighter classes, and thus less liable to injure itself through spirited exercise or playfulness. Furthermore, small bunches and blemishes which detract so seriously from the value of the harness horse or the saddle horse are not considered to be so objectionable in the draft horse. He can also be made to earn his own keep after he is 2 years old, and his education can be completed on the farm; thus the farmer who breeds him can secure his real market value. In the case of the coach horse or the saddle horse the middleman who educates him usually reaps a much greater profit than the man who produced him. This is not true of the draft horse.

Some of the essential points to be considered in selecting a draft horse are: Good feet and legs, plenty of weight, a well-developed body, and good style and action. A draft horse without good feet is worthless on any market, hence good feet are the very first essential of a draft horse, or in fact any class of horse. The hoofs should be large, round, and wide at the heel. They should have width, but not be too deep or too shallow. The horn should be of good quality, as indicated by its denseness. The wall must be strong and not inclined to be flat. The legs should be well set under the body and possess plenty of substance, as indicated by the quality and amount of bone and the development of muscle on the forearms and gaskins. Weight is a very essential point. A draft horse should weigh from 1,800 pounds upward, the more the better, provided it is combined with quality and good feet and legs. The body should be deep, wide, and strongly coupled, as indicated by the shortness of back and the muscling of the loin. Good action is essential, as indicated by the length of stride, quickness of step, and straight-away movement. Draft horses weighing 1,800 pounds and upward can be produced by breeding good draft mares, which combine size and quality, to a first-class sire of any of the recognized breeds of draft horses, as the Percheron, the Clyde, the Shire, and the Belgian. Any of these breeds contain many excellent horses. Each breed has its own peculiarities, perhaps advantages and

disadvantages. Be that as it may, be sure and select a good sire, one which possesses individual excellence backed up by good ancestry.

Fig. 43 shows the different parts of the horse, and is inserted for the benefit of those who are not familiar with the names of these various parts. The illustration will also be helpful in enabling the reader to follow the detailed description of the desirable points in the conformation of the various classes.

POINTS TO BE OBSERVED IN SELECTING A DRAFT HORSE.

In selecting a draft stallion the following points should be observed:

HEAD: Coarseness of the head must be guarded against; ears should be somewhat short, pointed, and not too wide apart at base; forehead

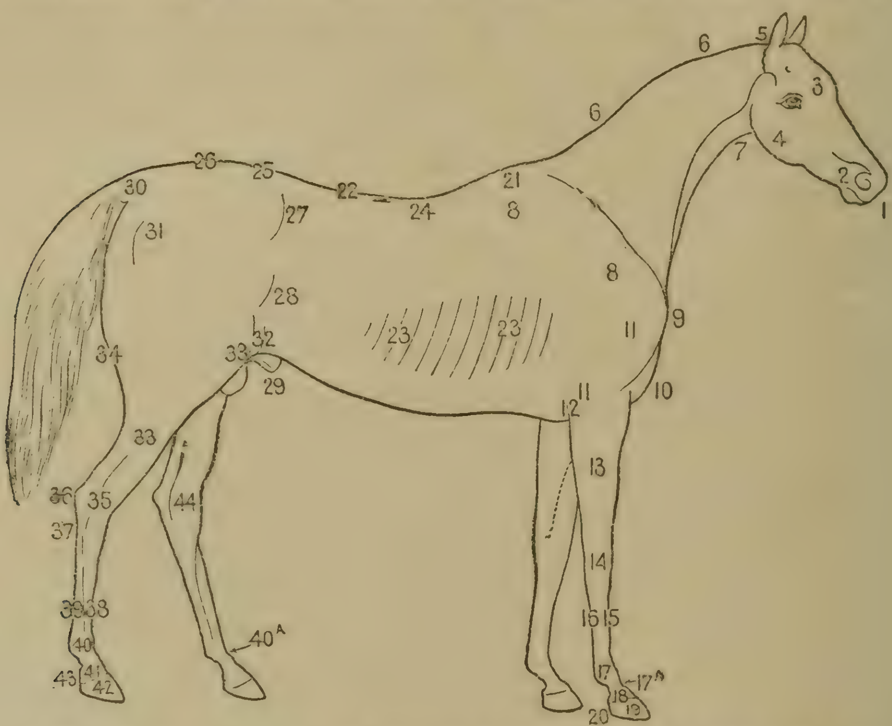

FIG. 43.—Points of the horse: HEAD—1, muzzle; 2, nostril; 3, forehead; 4, jaw; 5, poll. NECK—6–6, crest; 7, windpipe. FORE QUARTER—8–8, shoulder blade; 9, point of shoulder; 10, breast; 11, arm; 12, elbow; 13, forearm; 14, knee; 15, cannon bone; 16, tendon; 17, fetlock; 17A, pastern; 18, coronet; 19, hoof; 20, heel. BODY—21, withers; 22, back; 23, ribs; 24, girth; 25, loins; 26, croup; 27, hip; 28, flank; 29, sheath; 30, root of tail. THE HIND QUARTER—31, hip joint; 32, stifle joint; 33–33, gaskin; 34, quarters; 35, hock; 36, point of hock; 37, location of curb; 38, cannon bone; 39, back sinew; 40, fetlock joint; 40A, pastern; 41, coronet; 42, hoof; 43, heel; 44, location of spavin.

broad and rather flat, with a straight nasal bone; eye bright, full, and mild, with no appearance of a film to interfere with the vision (the natural shape of the eye is elliptical—a spherical form indicates blindness or impaired vision); nostrils large and pink in color; muscle of the cheek well developed; lips firm, and mouth of medium size.

NECK: Medium length, deep at junction of body, continuous with the withers without any line of demarcation; crest well arched, broad, and strong, but not so heavy as to turn to either side. Whole neck should be well muscled and surmounted by a good, heavy mane.

WITHERS: In a line with the neck, rather broad, well defined, and strongly muscled.

SHOULDERS: Medium slope. Extreme slope of shoulder is conducive to good action, but it is objectionable from a draft standpoint; on the other hand, a very upright shoulder is associated with a long back and stubby pasterns, conducive to poor action, as the direct concussion is very liable to cause sidebone. The muscles covering the blades should be well developed.

CHEST: Deep and comparatively broad, giving plenty of volume and lung room, which indicates stamina; legs must not be set on the outside, but well under body. When the legs are very wide apart the horse usually has a rolling action.

ARM: Bone forming arm short and sloping so as to bring the legs well under the body; also well muscled.

ELBOW: Strong and muscular, turning neither in nor out, but fitting closely to the chest.

FOREARM: Large and very heavily muscled. This is a very important point, and one in which a great many horses are very deficient.

KNEE: Well developed, broad from side to side and deep from before backwards; straight from a side view, neither bending forward, called knee sprung, nor backward, called calf knee. It is very important that the knee be well supported, as there should not be the slightest tendency to cut away beneath the knee—a very common defect in many otherwise good horses.

KNEE TO FETLOCK: That portion between the knee and the fetlock, called the cannon bone, broad and flat and free from meatiness; tendons wide, hard, prominent, and must not be tied in beneath the knee. In the case of the Clydesdale and the Shire there should be a fringe of fine, straight, silky hair starting from behind the knee and running to the fetlock. This hair is commonly called "feather," and should not be found on the front of the leg. In the Percheron and the Belgian not so much hair is found.

FETLOCK: Fetlock joint wide and well defined so as to give space for the proper attachment of the tendons that pass this joint.

FRONT PASTERNS: Medium length, strong, and fairly sloping. The slope of the pastern has much to do with the durability of the horse's feet and a marked influence on his action. A short, upright pastern causes direct concussion, which is very hard on the horse; if on pavement he will soon throw out sidebones. On the other hand, a draft horse may have too much length and slope of pastern, so much that he will be weak in his pasterns.

FRONT FEET: Good size, rather round, with a strong wall, not flat; heels wide, and neither too shallow nor too deep; horn dense, and not inclined to shelliness or brittleness; frog well developed; toes turning neither in nor out, but perfectly straight.

Body: The typical draft horse stands somewhat high in front, and the shoulders and withers blend nicely into the back, giving a short, strong appearance; ribs well sprung, with much depth; foreflank well filled out, indicating chest capacity, giving good lung room. A horse well let down in his hindflank has one of the best indications of a good feeder.

Loin: Thick, broad, and very heavily muscled, as it is here where the propelling power of the hindquarters is located.

Croup: Broad and heavily muscled, not too drooping, but out rather straight to the tail, well carried and full haired.

Haunch: Heavily muscled, thick through the ham, and hindquarters broad and well muscled.

Stifle: Well defined, strong, and well muscled.

Gaskin: Very heavily muscled, the bone large, indicating strength.

Hock: Large and strong and well developed in all directions; point well developed, back border straight, and joint free from puffiness.

Hock to fetlock joint: Cannon bone and feathering the same as in the forelegs; tendons well developed without pinched or tied-in appearance below the joint, and clean without any indication of meatiness or gumminess.

Fetlock joint: Broad, strong, and well defined.

Hind pastern: Medium length, slope, and of a strong conformation.

Hind feet: Large, though not as large as the front feet, of even size; horn dense; sole concave, with strong bars and a well-developed elastic frog; heel wide, one-half the length of the toe, and vertical to the ground.

Color: Bay, black, gray, brown, chestnut, sorrel, roan, with reasonable modifications so far as the face and leg markings are concerned.

Skin: Soft, mellow, loose, with a fine, glossy coat of hair.

Temperament: Energetic, docile, and not nervous.

Style and action: General appearance attractive; movement smooth, quick, long, elastic, balanced in the walk, and rapid, straight, and regular in the trot.

Weight: From 1,800 pounds upward.

Height: Sixteen and one-fourth to 17 hands.

The conformation of the draft mare and gelding is of the same general type as that outlined for the stallion, with the exception that they must not be so masculine in appearance. This would be especially noticeable in the neck, withers, and other parts which denote masculinity. The neck should be more delicate and cleaner cut, the crest not so well developed, and the withers not so broad, but better defined. The mare or gelding should not be over 16 hands in height.

Special stress should be paid to the feet and legs and quality, as they are of great value from a durability and market standpoint.

CARRIAGE, OR COACH, HORSES.

Next in importance to the draft horse for the farmer breeder is the carriage, or coach, horse. Some men who are naturally adapted to educating and training horses can produce carriage, or coach, horses much more profitably than draft horses. Horses of this class possessing the desired conformation, style, action, and speed command very high prices and are always in great demand. Perhaps at the present time there is a greater demand for good horses of this class at high prices than for any of the other distinct market types. This is due to two things: (1) Prosperous times in towns and cities have made it possible for many business men to keep such horses for pleasure driving, and (2) very few of them are produced, owing to the fact that most farmers have been following wrong methods in trying to breed such horses.

The ideal carriage, or coach, horse is an animal of high excellence of form, style, action, speed, and education. He must be of good size, standing from 15.3 to 16.2 hands high, and weighing in the neighborhood of 1,200 pounds and upward. He must be endowed with much style, as indicated by a clean-cut head, gracefully carried on a lengthy, well-arched neck, which must blend nicely with the shoulders and back so as to present an elegant contour. He must possess smoothness of back, loin, and hindquarters, which must not be too drooping. The tail should be well carried and full haired. He must have free, easy, high, and attractive action of both knees and hocks. In addition to high action, he must move in a straight line, as neither paddling nor rolling of the front feet is admissible. He must not go wide behind nor yet close enough to interfere. Action is an essential point and must receive due consideration in the carriage, or coach, horse. Speed, a few years ago, was not regarded as being necessary. At the present time, however, it is very much in demand, and adds very materially to the market value of this class of horses. Good feet and legs are essential points to be sought for in producing such a horse. Extremely high knee and hock action is very hard on the feet and legs. The duration of the period of usefulness in the carriage, or coach, horse will be increased or shortened by the conformation of the legs and the size and construction of the feet. The pastern should be sloping, so as to do away with direct concussion, which is so hard on the inner parts of the foot. The foot should be large, round, with a well-developed frog, and good width of heel.

The true high-class type of carriage, or coach, horse is difficult to produce. So many things are demanded of him, and if any one is lacking he is almost worthless. His production, notwithstanding his very complex nature, is not accidental, however. He can be produced with average regularity when proper methods of breeding are pursued.

Many enthusiasts have maintained that there was but one fountain head from which all ideal carriage, or coach, horses must arise, and that was the Hackney. They have had a fair trial, but in many instances have been found wanting. The progeny of the Hackney sire and the average mare in most instances has been unsatisfactory. Many of them possess good form, action, and style, but are lacking in size, speed, and stamina. The German coach, the French coach, and the Cleveland Bay have each their admirers, but they, like the Hackney, have in most instances fallen far short of reaching the desired standard. The progeny of such sires usually have sufficient size, style, and action, but they also are lacking in speed and stamina. It is also very difficult by using such a cross to get horses which have good feet and legs. The Cleveland Bay cross in most instances stands too high, and is thus liable to be weak in his legs. The most satisfactory way of producing the coach, or carriage, horse is by the use of a trotting-bred sire which has plenty of size combined with style and action. This method of breeding will usually give an animal with plenty of speed and abundance of stamina. The sire must have plenty of size, good bone, and feet.

POINTS TO BE OBSERVED IN SELECTING A CARRIAGE, OR COACH, HORSE.

In selecting a stallion for carriage or coach purposes, the following points should be observed:

HEAD: Ears of medium size, fine, and approaching each other at tips when pointed forward, and not too wide apart at the base; forehead broad and flat; bones of nose straight in front and slightly dished on lateral surfaces; muscles of cheek well developed; eye prominent, clear, and elliptical in shape; nostrils large and flexible; mouth of medium depth.

NECK: Rather long, head gracefully attached and carried well up; crest well developed and nicely arched.

WITHERS: Well developed and not too thick on top.

SHOULDERS: Sloping and well muscled. Slope of shoulders is very essential in the coach horse, as a sloping shoulder allows of a well-carried head and neck; is also associated with better action.

CHEST: Deep and of medium width. A wide chest, while indicative of constitution, is usually associated with rolling action.

ARM: Strong and thrown well forward.

ELBOW: Strong and muscular, turning neither in nor out, but fitting closely to the body.

FOREARM: Good length, strong muscles, well developed, and standing out boldly.

KNEE: Broad from side to side in front, deep from before backward, and straight in all directions.

KNEE TO FETLOCK: Cannon bone broad and flat, tendon well developed and prominent, skin lying close to bone and tendons, and not much tied-in beneath the knee.

FETLOCKS: Fetlock joint wide and well defined so as to give plenty of room for the proper attachment of the tendons which pass this joint.

FRONT PASTERNS: Sloping, medium length, and strong.

FRONT FEET: Good size, rather round, with a strong wall; heels wide and neither too shallow nor too deep; horn dense; wall strong and frog well developed.

BODY: Back short and strong; loins wide and well muscled; ribs well sprung and closely coupled with a good depth of flank.

CROUP: Medium width, carried out fairly straight to the tail, which should be full haired and well carried.

HAUNCH: Muscles well developed and standing out boldly.

STIFLE: Strong, well defined, and heavily muscled.

GASKIN: Strong and well developed, muscles standing out boldly and well defined.

HOCK: Large and strong in all directions, point well developed, posterior border straight, an absence of coarseness and puffiness.

HOCK TO FETLOCK JOINT: Cannon clean, broader and flatter than the fore ones, tendons standing boldly out and well defined without any indication of beefiness.

FETLOCK JOINT: Fetlock broad, strong, and well defined.

HIND PASTERN: Sloping, medium length, and strong.

HIND FEET: Same as front feet, but not quite so large.

COLOR: Bay, brown, black, chestnut, sorrel, roan, gray, with reasonable modification. White legs, especially in high-actioned horses, are often desired. In this class a good horse may be a bad color.

SKIN AND HAIR: Soft, mellow, loose skin; fine, silky coat of hair.

TEMPERAMENT: Energetic, docile, not sluggish, and free from nervousness.

STYLE AND ACTION: High and straight away; free and elastic, knee well bent; forefeet lifted well off the ground when in motion and brought straight forward, neither paddling nor rolling; stride long, with an absence of the tarrying action sometimes seen; hocks well flexed and hind feet lifted well up, not going wide nor yet close enough to strike opposite ankle. A horse which does not lift his front feet as high as his knees and his hind feet 7 inches off the ground when in motion is not considered to have high action.

WEIGHT: One thousand one hundred to 1,400 pounds.

HEIGHT: Fifteen and three-fourths to 16¾ hands.

The conformation of the coach mare and gelding is of the same general type as that outlined for the stallion, with the exception that they should not be so masculine in appearance.

THE ROADSTER HORSE.

Another class of horses in good demand at the present time is the gentleman's driving horse, or more commonly known as the roadster. A good and valuable roadster should not be considered as necessarily a race horse. Few race horses ever make satisfactory roadsters. The roadster should be of fair size, 15½ to 16 hands high, of good and graceful conformation, good color, stylish looking, a free driver, capable of traveling from 12 to 15 miles an hour. He must have good action; not especially high, but long, straight, and regular. He may either trot or pace. This class of horse is sired by a standard-bred sire, and so much the better if he is out of a trotting-bred dam. In this class, as in the other mentioned, size, combined with plenty of quality, is a necessity. Too many would-be roadster horses are worthless on account of lack of size. The ideal roadster is the animal that has sufficient size and strength combined with speed to enable him to draw two in a buggy over heavy roads. Many trotting-bred horses are also too light in bone. Thus, in breeding roadster horses, special attention should be given to size and bone, as they are very essential in the make-up of a high-class roadster horse.

POINTS TO BE CONSIDERED IN SELECTING A ROADSTER HORSE.

In selecting a standard-bred stallion the following points should be observed:

HEAD: Ear of medium size and pointed; eye large, prominent, and of docile expression; bones of the nose straight in front and slightly dished laterally; bones of cranium nicely rounded; nostrils firm, large, and readily dilated; muscles of cheek well developed, but not too heavy; mouth of medium size; lips firm; muzzle fine and tapering; branches of lower jaw well spread apart at their angles.

NECK: Rangy, with a well-developed crest and attached to the head in an angular sort of way, rather of obtuse order.

WITHERS: Should be continuous, with the superior border of the neck well developed, and not too broad.

SHOULDERS: Oblique from above downward and forward, blade well covered with muscles.

CHEST: Very deep through the girth; breast good depth and well filled.

ARM: Strong and well set in.

ELBOW: Well muscled and lying close to the chest.

FOREARM: Well developed and strong, with muscles well defined and standing boldly out.

KNEE: Straight and strong in all directions, free from malformations.

KNEE TO FETLOCK: Cannon bone rather short, broad, flat, and clean; tendons well defined and prominent, not tied-in beneath the knee, and free from beefiness.

FETLOCKS: Fetlock joint wide and well defined.

FRONT PASTERNS: Strong, of medium length and obliquity.

FRONT FEET: Of medium size, rather round, with strong wall; sole rather concave; frog large and well developed; heels broad, strong, and not too deep, toes turning neither in nor out.

BODY: Back straight and rather short; loin broad and well muscled; ribs of good depth, with well-marked angles.

CROUP: Broad, well muscled, and out straight to tail, which should be full haired and well carried.

HAUNCH: Muscles well developed, deep through ham; quarters broad and strong.

STIFLE: Strong, well muscled, and compact.

GASKIN: Muscles prominent and hard.

HOCK: Large and strong in all directions; all parts well developed; free from malformations and puffiness; posterior border straight.

HOCK TO FETLOCK: Cannon bone rather short, broader and flatter than in front; tendons clean and standing out prominently.

FETLOCK JOINT: Large and strong.

HIND PASTERN: Strong, of medium length and obliquity.

HIND FEET: Smaller and not so round as in front; sole more concave; frog well developed; heels strong and not too deep.

COLOR: Bay, brown, black, chestnut, roan, and gray, with reasonable modifications.

SKIN AND HAIR: Soft, mellow, loose skin; fine, sleek coat of hair.

TEMPERAMENT: Docile, kind, prompt, energetic, and not too nervous.

STYLE AND ACTION: Free and elastic; perfect in trotting gait; a good walker; must not paddle or roll in front; may go wide behind; may either trot or pace; must go level without hitting any part, and be able to go fast.

WEIGHT: One thousand pounds and upward.

HEIGHT: Fifteen to 16½ hands.

The above description will apply to the mare and gelding of this class, except that they will not be so masculine in appearance. The neck should be more delicate and clearer cut, the crest not so well developed, the withers more pronounced, not so thick through and through at the upper part, and there should be a slight line of demarcation between the withers and the neck.

THE SADDLE HORSE.

The saddle horse is always in good demand. He is almost without exception the progeny of the Thoroughbred and his descendant—the American Saddle Horse. The real high-class Thoroughbred possesses more quality than any other breed of horses. He is clean-cut, impressive, breedy looking in every respect. On account of his clean-cut appearance a coarser mare can be bred to this horse than to others. His progeny, except from extremely coarse mares, are seldom lacking in quality and ambition. Horses of this class are often called combination animals, being useful either in the saddle or as a harness horse.

There are two classes of saddle horses, the plain-gaited or walk, trot, and canter horse, and the American-gaited horse, which must go at least five distinct gaits, and possesses excellent manners. The market for a good-sized saddle horse is and always has been good. Most saddle horses are undersized. The heavy-weight saddle horse, capable of carrying up to 220 pounds and over, is a rare animal and always commands a very high price. He is much harder to produce than the smaller animal, and for this purpose a large mare should be selected, 1,200 pounds or more, with as much ambition and quality as possible, and bred to a good big Thoroughbred stallion, weighing in the neighborhood of 1,300. There is always a good demand for the lighter-weight saddle horse, but he does not command such a high price. The gaited saddle horse, or the combination gaited and carriage horse, is in good demand throughout the Central West. Kentucky and Missouri are both prominent in the production of horses of the latter class, which must be very attractive in appearance, docile in disposition, and as well mannered as the saddle horse, responding readily to the hand of his rider.

POINTS TO BE OBSERVED IN SELECTING A SADDLE HORSE.

The following points should be observed in the conformation of the Thoroughbred stallion:

HEAD: Ears fine, not too long, approaching each other at the tips when thrown forward; cranium broad and nicely rounded; forehead flat and broad; eyes wide apart, prominent, and bold in expression; nasal bones straight in front, but slightly dished on lateral surfaces; nostrils firm, large, and flexible, of large capacity when the animal is excited; lips firm; mouth medium-sized; muzzle small and tapering; cheeks well but not too heavily clothed with hard, well-developed muscles; branches of lower jaw well spread apart at their angles.

NECK: Clean-cut and rangy, crest well developed and whipcordy, but not so heavy as in other classes; head attached to neck in a graceful, angular manner; jugular gutter well developed.

WITHERS: Well developed, high, and not too wide on top.

SHOULDERS: Long and oblique so as to give easy action; shoulder blades well covered with muscles.

CHEST: Deep, giving good girth, with a well-filled breast.

ARM: Thrown well forward so as to give an oblique shoulder.

FOREARM: Long, well developed, and strong; well clothed with hard, well-developed muscles, having grooves of demarcation between them, showing the outlines of each individual muscle.

KNEE: Clean, straight, large, and strong in all directions, the bone forming the back part somewhat prominent.

KNEE TO FETLOCK JOINT: Cannon short, broad, flat, and clean; tendons standing out plainly, hard, and whipcordy. The lines of demarcation between tendon and ligament and between ligament and bone must be well supported beneath the knee, not showing any tendency of weakness.

FETLOCKS: Strong and well supported.

FRONT PASTERN: Strong, medium length, and oblique.

FRONT FEET: Rather smaller in proportion than in other breeds, round, strong, and fairly deep wall; sole concave, frog well developed; heels full and not too deep; toes neither turning in nor out while standing.

BODY: Back strong and inclined to be short, with a long underline; loin broad and well muscled; ribs well sprung and of good depth.

CROUP: Well muscled, carried out straight to tail, which should be full haired and very stylishly carried.

HOCK: Deep and strong in all directions; all points well developed, but not rough; absence of malformations or puffiness; point very well developed, straight on posterior border; the whole joint clean, hard, and of an angular order.

HOCK TO FETLOCK: Cannon short, wider and flatter than in front; tendons well marked individually, and must not have a pinched appearance below joint in front, but very gradually taper in width from hock to fetlock.

FETLOCK JOINT: Large, clean cut, and strong.

HIND PASTERNS: Medium length, sloping, and strong.

HIND FEET: Smaller and not so round as the front ones: sole more concave; frog well developed; heel good width and not too deep.

COLOR: Bay, brown, chestnut, black, roan, and gray, with reasonable modifications.

SKIN AND HAIR: Skin soft, mellow, and loose; hair fine, silky, and straight; hairs of mane and tail, although coarse, straight and soft in comparison with other breeds.

TEMPERAMENT: Mild, energetic, not vicious or too nervous.

ACTION: Prompt, free, and elastic; not too much knee and hock

action, but going rather close to the ground, especially in the canter and gallop; no paddle or roll, and front feet not to go close enough behind to interfere; a good straightaway walker.

WEIGHT: One thousand and fifty to 1,300 pounds.

HEIGHT: Fifteen and one-half to 16½ hands.

The above description will apply fairly well to the saddle horse, except that he will not be so masculine as the stallion. Unless he is a Thoroughbred he will not possess so much quality. He must have good manners, with a mouth that responds readily to the hand of his rider. He must also possess graceful and elastic action in all paces.

PROMISING NEW FRUITS.

By WILLIAM A. TAYLOR,
Pomologist in Charge of Field Investigations, Bureau of Plant Industry.

INTRODUCTION.

Among fruit growers interest in new fruits is perennial. The high prices at which judiciously advertised novelties in nursery stock are sold in large numbers each year testify to this. And while a large proportion of the sorts that receive wide notice from year to year drop out of sight soon after the self-interest of the introducers ceases to keep them before the public, many find lasting places of usefulness in localities where their special adaptability to local environment is proved by test. It is therefore well that new sorts shall continue to be tested by fruit growers from time to time, even in advance of their commercial introduction, for in no other way can rapid, continuous improvement in the character of the fruits of any region be accomplished.

Improved cultural treatment, including judicious fertilizing, tilling, pruning, and spraying, may accomplish much, but the best attention to any or all of these points fails to secure the desired economic end of largest yield and highest quality at least cost of labor, time, and money unless the effort is made upon varieties adapted to the local environment and which yield fruit suited to the purpose for which the product is to be used.

It is therefore advisable for growers to keep themselves informed regarding the more promising varieties of the fruits in which they are personally interested, and especially such as give evidence of having attracted attention through inherent merit, rather than through lavish praise by originators or introducers, for it is usually among such that the permanent improvements over previously existing varieties are found. A few fruits of this character that have reached the office of the Pomologist recently are described and illustrated in this paper.

The newness of some of the fruits mentioned rests rather upon the fact that they have hitherto had only local or, at most, restricted reputation, than upon recent origin. But they are believed to be none the less promising to the general fruit grower on that account. The fact of long test of such sorts in the localities of their origin or

restricted distribution is, in truth, their strongest claim to recognition, and it is because of this that they are suggested to growers as worthy of testing in other and larger fields.

STAYMAN WINESAP APPLE.

(SYNONYMS: *Stayman's Winesap; Stayman.*)

[PLATE LVII].

The Winesap apple has from a very early day been one of the most popular winter varieties, for both home use and market, in that great belt of country which extends from New Jersey, Virginia, and North Carolina to Arkansas, Kansas, and Nebraska. In more recent years it has assumed commercial importance at many points in the Rocky Mountain region and on the Pacific slope. Even before apples were grown for sale as fruit to any extent in the region in question it was prized as a cider variety. Thus, its standing as a cider fruit was recognized by Dr. James Mease in the first American edition of Willich's Domestick Encyclopedia, which was published at Philadelphia in 1804. In this work Dr. Mease, in his list of "Cyder apples," describes the Winesap as follows:

> WINE-SOP.—An autumn fruit, of deep red colour, and sweet, sprightly taste; makes excellent cyder, which is preferred by some to that of Red Streak;[a] cultivated by Samuel Coles, of Moore's-town, New Jersey.

Dr. Mease's account is worthy of special notice from the fact that it was, in the language of the author, "the first attempt ever made to collect into one view a list of the finest kinds of apples growing in the United States." This antedated by thirteen years Coxe's "View of the cultivation of fruit trees," published also in Philadelphia, in 1817, which has usually been considered the beginning of systematic pomology in America. Dr. Mease's observations appear to have been chiefly limited to eastern Pennsylvania and New Jersey, but fortunately included the collection of William Coxe at Burlington, then about ten years established, as well as several others of that region; so that his list includes the earliest known descriptions of about forty varieties of apples that are still grown, in addition to a number that are probably not now in existence.

Coxe in 1817 described and illustrated the Winesap in his work above noted, and characterized it as then "becoming the most favorite cider fruit in West Jersey." He commended it highly on the score of its productiveness, but noted its unsatisfactory habit of growth, which still remains its chief defect as an orchard tree. Nothing appears to be known regarding its time and place of origin. Neither Mease nor Coxe refers to these points. It has been assumed by

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[a] Red Streak was one of the famous English cider apples grown in this country at that time.

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STAYMAN WINESAP APPLE.

subsequent writers that it originated somewhere in western New Jersey at some time prior to the year 1800.

As would be expected, a variety with so many strongly marked characteristics, grown under such varied soil and climatic conditions as are found from the Atlantic to the Ozarks, has left a marked impress on the pomology of this great region. It is a singular fact, however, that so far as known nearly all of those newer varieties which show strong evidence of Winesap parentage have originated west of the Allegheny Mountains. Among these may be mentioned Kinnard, Paragon, and Gilbert, of Tennessee; Arkansas (synonym *Mammoth Black Twig*) and Arkansas Black, of Arkansas Howsley; and the several seedlings grown by Dr. J. Stayman, of Leavenworth, Kans., of which last the Stayman Winesap has been most widely disseminated.

During the past six or eight years Stayman Winesap has been widely discussed by commercial fruit growers throughout the Eastern United States. According to the statement of its originator, it was one of a lot of seedlings grown at Leavenworth, Kans., in 1866, from seed selected from a choice lot of Winesap apples grown in the same county. About a dozen of the most promising seedlings of the lot, as judged from foliage and wood, were transplanted to permanent locations in 1868 and allowed to attain fruiting age. When they came into bearing, so large a proportion of them were considered promising that Dr. Stayman sent out scions of several to parties in Kansas, Minnesota, New Jersey, Ohio, Pennsylvania, and Virginia for testing. Of the lot, at least three, besides the Stayman Winesap, appear to possess distinct merit, the others having been more or less disseminated under the designations Stayman Nos. 1 and 2 and Stayman Sweet.

The variety described and illustrated in this paper first produced fruit in 1875, and the first published description of it appeared under the name "Stayman's Winesap" in Charles Downing's third appendix to the second revised edition of "Fruits and fruit trees of America," published in 1881. Dr. Stayman also published a description of the variety in the Annual Report of the Missouri State Horticultural Society for 1883. The original tree of this variety was destroyed by a storm several years ago, but those of the other seedlings were reported to be still standing in January, 1903.

Further than these descriptions the variety does not appear to have attracted any special attention until after 1890, when its good qualities were discovered almost simultaneously by Mr. R. J. Black, of Bremen, Ohio, and Mr. J. W. Kerr, of Denton, Md., both of whom fruited it on top grafts at about that time. It was first catalogued by the latter in 1894–1895, and has been quite extensively planted in New Jersey, Pennsylvania, Delaware, Maryland, and Virginia since that date, and somewhat in other States. Its chief merits

are its exceptionally vigorous growth of root and top, its large and luxuriant foliage, which enables the tree to carry its full crop up to maturity, and the excellent quality of the fruit, superior in this respect to that of its parent. The only particular in which it does not equal the parent is in its color, which is somewhat less brilliant than that of the old variety. The fruit is sometimes subject to barrel scald in storage when picked before reaching full maturity, being quite similar to the parent in this respect. Taking all important points into consideration, the Stayman Winesap appears to be adapted to a wider range of soil and climate than its parent and to be well worthy of testing, both for home use and market, throughout middle latitudes.

The specimen shown on Pl. LVII was grown by Mr. J. W. Kerr, at Denton, Md., and is fairly representative of the variety as it grows on the Chesapeake Peninsula.

DESCRIPTION.

Form roundish conical, with some specimens slightly oblique; size medium to large, averaging considerably larger than Winesap; surface smooth; color greenish yellow, washed and faintly striped with rather dull mixed red, thinly splashed and striped with crimson; dots numerous, russet, many aureole; cavity regular, large, deep, russeted; stem short, rather stout; basin regular, small, shallow; calyx segments long, narrow, converging, reflexed at tip; eye of medium size, closed; skin moderately thick, tenacious; core oval, small to medium, moderately open; seeds numerous, plump, brown, of medium size; flesh yellowish, moderately fine-grained, breaking, juicy; flavor sprightly subacid, good to very good. Season winter, keeping well in common storage and apparently well adapted to cold storage.

The tree is a strong, moderately upright grower, with dark wood and large, healthy foliage. It promises to be much longer lived than the parent, and is apparently adapted to regions somewhat farther north than the old Winesap is known to succeed.

RANDOLPH APPLE.

(SYNONYM: "*Unknown.*")

[PLATE LVIII.]

Among the varieties of summer apples tested in the experimental export shipments conducted by the Department of Agriculture in 1902, one of the most promising sorts for long-distance shipment was the Randolph. The origin of this variety is not known, its history, so far as ascertained, being as follows: When the late Randolph Peters, of Wilmington, Del., bought the farm near Farnhurst, Del., where he established a nursery about 1869, he found upon it an apple orchard. In this orchard there were one or more trees of a summer apple not recognized by him, which impressed him with its value as a commercial variety because of its firm flesh, sprightly flavor, and

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RANDOLPH APPLE.

brilliant color, yielding fruit uniformly fair and smooth. Supposing it to be an old variety, he sent specimens for identification to various pomologists, including the late Charles Downing. None of the experts recognized the variety, and Mr. Peters, considering it worthy of dissemination, dubbed it "Unknown," and offered it for sale in his catalogue as early as 1884 under that name. From this nursery it was quite widely introduced, and in recent years has attracted attention in Nebraska, Arkansas, Maryland, and Delaware, being most widely grown in a commercial way in the last-mentioned State. One of the first to recognize its merit after it was distributed by Mr. Peters appears to have been Mr. H. T. Vose, of West Point, Ark., then of Otoe County, Nebr. Mr. Vose states that he solicited and obtained the consent of the introducer to name it "Randolph," in honor of the discoverer.

While not of the highest dessert quality, the Randolph is a good eating apple of mild flavor, distinctly better than most varieties of its season, with a firmness of texture and brilliance of color that render it one of the best summer varieties for long shipment by either rail or sea. Mr. Vose reported it in 1895 as the most vigorous grower in his collection of sixty or more varieties, and an early, annual bearer, ripening about two weeks later than Red June. The fruit sets singly or rarely in pairs on the fruit spurs, and as it does not overload, its crop is more even in size than varieties that set their fruit in clusters.

On Plate LVIII is illustrated a specimen grown by Mr. Thomas O. Duvall, Spencerville, Montgomery County, Md., in 1902.

DESCRIPTION.

Form oblate, very symmetrical; size medium to large; surface smooth and glossy; color creamy white, washed with crimson and beautifully striped with darker crimson; dots few, gray, indented; cavity regular, of medium size and depth and gradual slope, striped and russeted; stem short to medium, rather stout; basin regular, of medium size and depth and abrupt slope, slightly furrowed; skin thick, tenacious; core medium, oblate conic, partially open, clasping the eye; seeds plump, brown, medium, numerous; flesh yellowish, with a satiny luster, moderately fine-grained, very firm, breaking, moderately juicy; flavor mild subacid, good. Season second half of July in Delaware and tide-water Maryland.

The tree is a vigorous grower, with brownish wood and light dots. It is regularly and sufficiently productive.

The variety is considered by Mr. Duvall the most profitable summer apple of his section in Maryland, and from its behavior in the experimental export shipments referred to it is considered well worthy of testing as a commercial summer apple throughout the country.

PHILOPENA PEAR.

[PLATE LIX.]

To the regret of pear lovers who appreciate varieties chiefly, if not solely, for their flavor and quality, the trend in American pomology in recent years, as judged by the character of varieties introduced, has been toward superficial beauty, size, and productiveness rather than toward marked improvement in dessert quality. The necessity for varieties resistant to diseases affecting foliage and fruit has played an important part in fostering this tendency. This is especially true as regards the disease known as pear blight, to which many of the finer sorts have succumbed in the South, and which renders the culture of pears an uncertain undertaking in the Middle States, especially in the great Mississippi Valley. It is unfortunate that the planting of a number of the finer dessert sorts has practically ceased in the regions mentioned, their places having been taken by the more vigorous and resistant varieties of the Oriental type, none of which has yet developed high dessert quality.

The fact that Seckel and a few others of the European type have persisted here and there throughout the region in question, where Bartlett, Clapp Favorite, Flemish *Beauty*, and other popular sorts have succumbed, has given rise to the hope, among some growers, that through the agency of seedlings of these more resistant sorts varieties may ultimately be developed that will be sufficiently blight resistant to endure the existing conditions and at the same time retain the high quality of the parent varieties.

Among the most promising varieties in this respect is the Philopena, shown on Pl. LIX. Its record well illustrates the vicissitudes that frequently attend the early history of fruit varieties which subsequently prove their value through the possession of some strongly marked characters.

The essential facts, as related by Mr. W. H. Ragan, are as follows: In 1843 the late Joshua Lindley, who had for some years conducted a nursery at Monrovia, Ind., closed out his stock preparatory to returning to his former home in Guilford County, N. C. The late Reuben Ragan, of Putnam County, Ind., purchased part of this stock. Among it was a long-bodied seedling pear tree, in which was a dormant bud of the Aremberg (synonym *Beurre d'Aremberg*) pear. As the latter was a rare and high-priced variety in the region at the time, this tree was given special attention by the owner, with the natural result that a strong and thrifty top was quickly grown from the Aremberg bud. About 1847, during one of those epidemics of pear blight which have repeatedly devastated the trees of the region, the Aremberg top was attacked by the disease and killed down to the seedling stock. Little attention was subsequently paid to the tree until it came into bearing. It was then found to yield a delicious late fall pear of medium size,

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PHILOPENA PEAR.

which was named Philopena by the originator some time between 1850 and 1860.

It appears to have been first described in the Report of the Secretary of Agriculture for 1889 (p. 444).

It has been propagated locally in Putnam County, Ind., and disseminated to some extent by distribution to experimenters through the Department of Agriculture. While its parentage is not known, it strongly resembles in certain characters both Seckel and Louise *Bonne de Jersey*.

Pl. LIX shows a fair-sized specimen of this fruit grown on the original tree in 1901, by Mr. R. M. Ragan, at Fillmore, Ind.

DESCRIPTION.

Form oblong pyriform, tapering sharply to the stem; size medium, or slightly below; surface moderately smooth; color dark yellow, lightly russeted, and showing a brownish blush on side exposed to the sun; dots numerous, small, russet; cavity obsolete, stem of medium length, and diameter, obliquely inserted; basin regular, small, shallow, slightly furrowed; calyx segments small, converging; eye small, closed; skin rather thick, tenacious; core oval, of medium size, closed; seeds of medium size, plump, brown, numerous; flesh yellowish, fine-grained, meaty, moderately juicy; flavor sweet and rich; quality good to very good. Season, October and November in central Indiana.

The original tree, now more than sixty years old, is still in thrifty condition, bearing annual crops. It is an upright but rather straggling grower, the young wood having a yellowish-green color. The variety appears worthy of experimental planting throughout the Middle States.

BELLE PEACH.

(SYNONYMS: *Belle of Georgia; Georgia.*)

[PLATE LX.]

The Chinese Cling group of peaches has, in recent years, demonstrated its adaptability to a much wider range of climatic conditions than was formerly supposed to be the case. Elberta, the best known variety of this group, has already proved a successful and profitable commercial sort from Georgia and Texas to Michigan and Connecticut. Among the varieties of this group that are less widely known, perhaps none possesses more valuable points than that which was introduced to cultivation by Dr. S. H. Rumph about 1883, under the name "Belle." The variety was afterwards catalogued by many nurserymen as "Belle of Georgia." The name was published as "Georgia" in the catalogue of the American Pomological Society for 1899, the fact that this name had already been published for at least three other varieties having, in the chaotic state of pomological nomenclature, apparently escaped notice.

It is a remarkable fact that Elberta and Belle were grown as seedlings from the same crop of fruit of one Chinese Cling tree in Georgia. The early history of Belle is thus recorded by Powell[a] from information furnished by the originator:

Seedling of Chinese Cling possibly crossed with Oldmixon Free. Originated with Mr. Lewis A. Rumph, Marshallville, Ga., from seed from a Chinese Cling tree in the variety orchard of Dr. S. H. Rumph, Marshallville, Ga. The original Chinese Cling tree stood in the center of the variety block near some Oldmixon Free, Oldmixon Cling, Crawford Early, and Crawford Late trees. Mr. L. A. Rumph planted the stone in the fall of 1870 from the same tree, and at the same time S. H. Rumph planted a stone that produced the Elberta.

Though slower than Elberta to attain popularity in the North, Belle is found to endure lower winter temperatures without injury and to be more reliably productive than the former variety in some sections. The only important objection to it, from the commercial standpoint, appears to be its white color, which may render it less popular in markets that prefer yellow-fleshed sorts.

DESCRIPTION.

Form roundish oblong, in the South often tapering to a distinct point, usually symmetrical; size medium to large; surface smooth, soft, and velvety; color creamy white, with a beautiful crimson blush on the side exposed to the sun, sometimes marbled with crimson; down short, adherent; cavity regular, small, shallow, abrupt; suture shallow, except at cavity and apex; apex small and depressed in suture in Northern-grown specimens, frequently large, prominent, and pointed in the South; skin thin, tenacious; stone oval, of medium size, and free; flesh whitish, tinged with red at stone, tender, melting, and juicy when ripe, though sufficiently firm for shipment when picked in advance of full maturity; flavor subacid, rich, and pleasant; quality good to very good. Season, late July at Fort Valley, Ga., late August in northern Virginia and Missouri, beginning to ripen slightly in advance of Elberta, but ending at about midseason of that variety.

Tree vigorous, spreading, rather slender, hardy, and productive. Leaf glands small, reniform; blossoms small.

It is one of the most promising white-fleshed freestones for the commercial peach districts, especially on light and dry soils.

WILLETT PEACH.

(SYNONYM: *Willett's Seedling.*)

[PLATE LXI.]

This promising yellow freestone is reported to have originated from a stone brought from some point in South America by the late Cornelius O'Bryan, of "Bryant's Minstrels," who planted it in his garden

[a] Bulletin No. 54, "The Chinese cling group of peaches," 1902, p. 20, Delaware College Agricultural Experiment Station.

BELLE PEACH.

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WILLETT PEACH.

at No. 110 West Fortieth street, New York City, some time prior to 1867. The property came into possession of Mr. Wallace P. Willett in 1874, and the tree was in that year large and in full bearing, carrying several bushels of fine fruit. It was crowded by buildings and fences, which necessitated frequent and severe pruning, but it survived until about 1888 or 1889. Twelve selected specimens of the fruit from the original tree were exhibited by Mr. Willett at the American Institute Fair in 1874. These specimens weighed 12 ounces each and measured 12 inches each in circumference. On this exhibit he was awarded the diploma of the institute for "Seedling peaches."

The following year Mr. Willett furnished a few scions to C. L. Van Duzen, of Geneva, N. Y., who first propagated the peach and who introduced it in 1876 under the name "Willett's Seedling," which has since been reduced to Willett, in conformity with the rules of nomenclature of the American Pomological Society.

The variety does not appear to have been widely advertised or distributed, but demand for the trees has been found to grow steadily in recent years, as its worth has been recognized in different portions of the North. Its hardiness in fruit bud, beauty, excellent shipping quality, and special adaptability for canning, preserving, and brandying make it one of the most promising medium late varieties for the Northern commercial grower. Unfortunately, the stock of the variety in the nurseries appears to have been considerably mixed, so that in many cases inferior sorts have been sent out under the name; hence care should be exercised by planters to secure stock true to name.

DESCRIPTION.

Form roundish obovate, conical, often unequal; size large to very large; surface very soft and velvety, covered with short, loose down; color rich deep yellow, deeply blushed, and occasionally striped with crimson; cavity very large, deep, and abrupt; suture shallow except at cavity and apex; apex moderately prominent; skin moderately thick, tenacious; stone of medium size, oval, free; flesh rich yellow, stained with red at the stone, firm and compact, yet juicy; flavor sprightly subacid; quality good, especially desirable for preserving.

Tree vigorous, foliage large; glands reniform; blossoms large.

Commended to commercial planters who find demand for a high-grade yellow freestone to follow Elberta.

The specimens shown on Pl. LXI were received from Mr. Wallace P. Willett, East Orange, N. J., in 1900.

BRITTLEWOOD PLUM.

(SYNONYM: *Brittlewood No. 1.*)

[PLATE LXII.]

In regions where temperatures lower than $-20°$ F. are frequently experienced, the varieties of the Domestica type of plums, which

constitute the main dependence in the milder fruit regions of the North, maintain but an uncertain existence, and are not infrequently entirely destroyed by freezing. Fruit growers of the Upper Mississippi Valley in particular have sustained heavy losses in this way and have been devoting careful attention to the development by selection or breeding, or by both methods in combination, of varieties of the hardy native plum of that region (*Prunus americana* of the botanists). The result has been that a large number of wildings of greater or less promise have been transplanted to gardens and christened and introduced to the public through the medium of commercial nurseries. The large majority of these have proved to be of but doubtful value, but among them and the seedlings grown from them, some very distinct improvements over the wild type are appearing.

One of the best of these is the variety originated by Mr. Theodore Williams, of Benson, Nebr., from seed of Quaker, pollinated by Harrison Peach, the former one of the earliest introductions of this species, and one of the best in quality. Brittlewood was commercially introduced by Mr. J. W. Kerr, of Denton, Md., in 1896.

DESCRIPTION.

Form globular, symmetrical; size large for the Americana type; cavity small, shallow; stem short, slender; suture shallow; apex slightly depressed; surface smooth; color light coppery red, covered with a heavy bluish-white bloom; dots numerous, minute, russet; skin thick, tenacious, free from bitterness; stone oval, rather large, cling; flesh yellowish, translucent, meaty, juicy; flavor mild subacid, rich; quality very good. Season end of August in eastern Nebraska.

Tree strong, spreading, vigorous; worthy of thorough testing in the North.

The specimen shown on Pl. LXII was grown by Mr. Theodore Williams, of Benson, Nebr.

STODDARD PLUM.

[PLATE LXII.]

Unlike the Brittlewood, which grew from planted seed, the Stoddard plum appears to have been a wilding.

It was first brought to notice by Mr. B. F. Stoddard, of Jessup, Iowa, about 1875, who found it growing in the garden of Mrs. Caroline Baker, of that village. Mrs. Baker states that her husband secured the trees during the early settlement of the region at some point farther north, presumably in the woods, on the Maquoketa River. Her belief as to the locality of origin is strengthened by the fact that Mr. Elmer Reeves, of Waverly, Iowa, informs the writer that he found a yard in the village of Sumner full of trees of the same variety, which had been brought from near the Maquoketa River.[a]

[a] Letter of Elmer Reeves, January, 1903.

GRAY LITH CO N.Y

BRITTLEWOOD AND STODDARD PLUMS.

JORDAN ALMOND.

The variety was commercially introduced by the Wragg Nursery at Waukee, Iowa, about 1895, and has been found adapted to conditions at many points between Nebraska and Maryland.

DESCRIPTION.

Form roundish, slightly oblique; size medium; cavity small, shallow; apex minute, depressed; surface smooth; color deep purplish red, with bluish white bloom; dots numerous, minute, yellow; skin rather thick and tough, acid but only slightly astringent; stone oval, of medium size, cling; flesh deep yellow, translucent, tender, juicy; flavor mild subacid, rich; quality good.

Tree strong, vigorous, and productive. A valuable sort for the North and West.

The specimen shown on Pl. LXII was received from the late Prof. E. S. Goff, of Madison, Wis., in 1901.

JORDAN ALMOND.

[PLATE LXIII.]

The exact identity and the place of production of the commercial supply of the Jordan almond were until quite recently shrouded in obscurity. Under the name "Jordan" considerable quantities of almond kernels of large size, symmetrical form, and delicate flavor have long been known in the markets of England and America. These kernels were said to have come from Malaga, Spain, where a single firm practically controlled the product and exported it entirely in the form of shelled kernels. A search of European nursery catalogues failed to afford any clue to the identity of the variety or the source from which the nuts came, and steps were accordingly taken by the Department of Agriculture, through its Division of Pomology and Section of Seed and Plant Introduction, to locate the variety in its region of commercial production and secure authentic stock for testing in the almond districts of the United States. This end was accomplished by Mr. David G. Fairchild, agricultural explorer, who, during the summer of 1901, visited southeastern Spain, investigated the orchards, and secured scions from bearing trees. From these scions trees were propagated that are now growing at several points in the United States, and may soon be expected to yield fruit.

Meanwhile, Mr. John Rock, of Niles, Cal., had secured, early in 1897, through a French correspondent, some dormant budded trees propagated on myrobalan plum stock in France from scions obtained in Spain in 1896. Fearing that the almond would not thrive on myrobalan roots in California, Mr. Rock grafted 100 of these dormant buds upon bearing peach trees, using as a scion the entire trunk of the myrobalan plum stock with the dormant almond bud upon it.

Nearly all grew and came into bearing, but only three of these proved to be of the true "Jordan" type, the others varying greatly, and most of them proving worthless.

The nuts shown on Pl. LXIII are from one of these trees on Mr. Rock's grounds, and the nuts from them submitted to dealers in Malaga, through United States Consul Ridgely, were pronounced the true "Jordan" type. The distinctive characters of the type are well shown in the illustration. Whether more than a single variety is marketed under this name yet remains to be determined. The name "Jordan" has been supposed by some to be a corruption from the French "jardin," meaning "garden," but no evidence of the accuracy of this conclusion has been discovered.

The Jordan almond[a] seems worthy of testing in the milder commercial almond districts, especially in those where late spring frosts are of rare occurrence.

DESCRIPTION.

Form long, narrow, but plump, distinctly curved along the ventral suture; hull thin, downy, loosening readily from the nut; shell smooth, dense, hard, and thick, with a very smooth inner surface; kernel long, narrow, smooth, light brown, of fine, firm texture and delicate, rich flavor. As imported, the kernels are highly esteemed by confectioners for the preparation of candies and "salted" almonds, the prepared kernels usually retailing from 50 to 60 cents per pound in the latter form. Mr. Fairchild states that the various grades of kernels are designated in Spain according to size by the names of animals, such as "donkeys," "horses," "tigers," "lions," "elephants," and "mammoths," the "donkeys" being the smallest and the "mammoths" the largest grade. The sizes are separated by hand picking.

The common method of propagation, as observed in Spain by Mr. Fairchild, is to bud on bitter almond seedlings two years or more old, in the orchard at a height of 2 to 4 feet from the ground. Like other almonds, the Jordan blossoms very early in spring, and is therefore susceptible to injury by late spring frosts. Its culture will therefore probably be limited to localities specially favored in this respect. It is, presumably, considerably less hardy than the common hard-shell almond or the hardier peaches.

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[a] For a fuller account of this almond as grown in Spain, see Bulletin No. 26, Bureau of Plant Industry, U. S. Dept. Agr., "Spanish almonds and their introduction into America."

PROGRESS IN SECONDARY EDUCATION IN AGRICULTURE.

By A. C. True, Ph. D.,
Director of the Office of Experiment Stations.

DEVELOPMENT OF AGRICULTURAL COLLEGES.

During the past few years there has been a rapid growth of interest in questions relating to courses in agriculture of secondary grade. This has been due to several causes operating at the same time. The faculties and equipment of the agricultural colleges have of late been very materially strengthened. The number and variety of the courses in agriculture which they offer have consequently been greatly increased. They are also engaging much more largely in various forms of university-extension work, through the farmers' institutes, correspondence courses, etc. They are thus attracting a larger number of students. The statistics show that the total number of students enrolled in college courses in agriculture in the United States in 1902 is 6,299, as compared with 3,930 in 1897. But all this development of the agricultural colleges has only served to bring out more clearly the fact that under the best conditions, if they are to maintain their standing as colleges, they can meet the educational requirements of only a small fraction of the youth on our farms. If any considerable body of the farm boys and girls are to receive definite instruction in the principles of agriculture, it must be in schools of lower grade than the colleges. In this respect agriculture stands on just the same footing as any other branch of learning.

ELEMENTARY PUBLIC SCHOOLS AND AGRICULTURAL INSTRUCTION.

When we turn to the elementary (district or graded) public schools we find that neither their present condition nor the possibilities of their future development warrant the conclusion that any considerable amount of agricultural instruction can be included in their curriculum. Without doubt, their courses of instruction can be much improved, so as to inculcate a love of nature and country life, and to impart many facts and a few principles which will be of direct and lasting benefit to the young people who will go out from them to spend their lives on the farms; but in schools of this low grade it will never be possible to teach the sciences related to agriculture or

to give any systematic instruction in the theory and practice of agriculture itself. Reading, writing, arithmetic, geography, United States history, drawing, music, and the elements of English grammar and composition must always constitute the chief factors in the common-school curriculum. When the schools are thoroughly graded and are taught by well-trained teachers, a limited amount of nature study, woodworking, cooking, sewing, and the elements of agriculture may be added; but not enough instruction regarding any art can be given to enable the student to understand the scientific principles on which practice is based or to become proficient in the practice. This must be done, if at all, in schools of higher grade.

RECENT DEVELOPMENT OF PUBLIC HIGH SCHOOLS.

For the above reasons the friends of agricultural education are now turning their attention more and more to the problems relating to courses in agriculture in the secondary (that is, the high) schools. In this they are but following the path already being pursued by those who are interested in the development of industrial education in other lines. There is no more notable fact in the educational progress of the United States during the past decade than the rapid development of the public high school. The Bureau of Education reports that in 1900 there were 6,318 public schools of high-school grade in the United States, as compared with 2,771 in 1890. The number of students attending such schools has risen from 211,596 in 1890 to 541,730 in 1900. Along with this remarkable growth in the number of schools and students there has been a great change in the aim of the high schools, and consequently in the number and kind of courses offered by them. They were originally established primarily as fitting schools for the colleges, and hence their courses consisted very largely of English, Latin, Greek, and mathematics. With the increase of interest in the natural sciences, courses in the elements of several of these sciences were gradually introduced; and for the students not intending to go to college English literature, history, civil government, political economy, drawing, and music were added. But hardly had the public acquiesced in any general way in the idea that secondary schools should be maintained by taxation when there began to be a demand that these schools should direct their attention to meeting the educational needs of young people generally rather than devote themselves so largely to the limited number of pupils expecting to prepare for colleges. Every concession made to this demand by the high schools has greatly increased their popularity and led to wider demands for the broadening of their courses. Then it was discovered that if they went on simply enlarging their literary and scientific courses they would not properly fit their students to engage with success in the industrial pursuits to which the vast majority of them must necessarily devote their lives. This proved to be especially so

in the case of young men, who therefore very largely neglected the high-school courses; and even to-day a great majority of the high-school students in this country are girls. But meanwhile technical schools were being established and their graduates were demonstrating the advantages to be derived from such instruction in the competitions of various forms of industrial life. Within recent years there has also been a great increase in the number and variety of pursuits requiring some scientific knowledge combined with manual skill for their successful prosecution. The special technical schools, with their long and expensive courses, can not fully meet the demands for such instruction. The people have therefore appealed to the high schools, with the result that wherever the voters are willing to tax themselves for these purposes technical and industrial courses are being introduced into these schools. This is carried to such an extent in some cities that there are already separate business and manual-training high schools with elaborate courses.

WASHINGTON MANUAL TRAINING HIGH SCHOOL.

At Washington, D. C., separate manual training high schools are maintained for white and colored students. The character of the courses given in these schools is indicated in the following statements taken from their printed programme:

For both boys and girls the general plan of instruction in these schools comprises prescribed courses in English, mathematics, physics, chemistry, freehand drawing, and design, and optional courses in German, French, history, and biology.

For boys, shopwork and mechanical drawing are prescribed in each year, and practice is given in caring for the boilers, engines, dynamos, motors, etc., which constitute the heating, lighting, and power plants of the building.

For girls, courses in domestic science and domestic art are prescribed, including individual work in cooking, the preparation and serving of meals, invalid cookery, marketing, laundry, methods and materials, management of the house, plain sewing by hand and machine, dressmaking, and millinery.

Three four-year courses and a two-year course are offered. On the page following one of the four-year courses is given. The other four-year courses are designed especially to prepare pupils respectively for normal schools and for scientific and technical schools of college grade. These courses include German and French, and devote relatively less time to technical and scientific work than is the case with the course published by the committee. The two-year course gives double time to shopwork and mechanical drawing or to domestic science and domestic art, covering substantially the same ground in these subjects as do the four-year courses. The academic work is accordingly lessened.

Course of study in Washington manual training schools, special four-year course.

First year.	Second year.	Third year.	Fourth year.
English.	English.	English.	English.
History.	History.	Solid geometry.	Mechanics.
Algebra.	Geometry.	*Trigonometry and surveying.*	Electricity or advanced chemistry.
Physics.	Physics.	Physics or chemistry.	Drawing:
Drawing:	Chemistry.	Drawing:	Freehand.
Freehand.	Drawing:	Freehand.	Mechanical.
Mechanical.	Freehand.	Mechanical.	Shopwork:
Shopwork:	Mechanical.	Shopwork:	Machine-shop work.
Joinery.	Shopwork:	Machine-shop work.	Domestic science.
Wood turning.	Foundry work.	Domestic science.	Domestic art.
Pattern making.	Forging.	Domestic art.	
Domestic science:	Domestic science:		
Cooking.	Cooking.		
Domestic art:	Laundry.		
Plain sewing.	Domestic art:		
Dressmaking.	Dressmaking.		

NOTE.—In the third and fourth years of the course pupils may substitute for solid geometry or mechanics an equivalent amount of work in physics, chemistry, biology, or manual training, one hour of recitation being taken as equal to two hours of laboratory or shop practice. Optional studies are printed in *italics*.

In the other four-year courses instruction in French and German is given.

SPRINGFIELD MECHANIC ARTS HIGH SCHOOL.

At Springfield, Mass., there is a mechanic arts high school in which there are three courses of instruction, two of them differing principally in the relative amount of time given to academic studies and to the mechanic arts, and the third based upon the requirements for admission to the best schools of technology. The academic work of the regular course is practically equivalent to the general course in any high school. In addition to this a thorough course in drawing and the elements of the mechanic arts is given. It is designed for boys who do not intend to continue their training in higher scientific or technical schools, but wish to derive the greatest possible advantage from this school and have the ability to do work demanded by the course. Experience has shown that a large percentage of the boys who have taken similar courses in manual training high schools have readily found employment in desirable positions in which their scientific and manual training proved to be of great service.

The programme of the regular course is as follows:

Course of study in Springfield, Mass., Mechanic Arts High School (regular course).

First year.	Second year.	Third year.	Fourth year.
Algebra. Elementary physics. English language and literature. History. French. Mechanical and free-hand drawing. Joinery. Wood turning and metal work.	Plane geometry. Mechanics. English language and literature. History. French. General physics. Mechanical and free-hand drawing. Pattern making. Molding. Vise work. Forging.	Chemistry. Advanced physics. English language and literature. History. French. Mechanical and free-hand drawing and machine-shop practice (alternate days).	Trigonometry and review in mathematics. Applied mechanics (optional).[a] Electrical measurements (optional).[a] Steam engineering (optional).[a] English language and literature. History and civics. Mechanical and free-hand drawing and machine-shop practice (alternate days).

[a] One optional study required.

Similar technical high schools, with well-balanced industrial or commercial courses, are maintained in nearly every large city and in many of the medium-sized cities in the United States.

THE ELECTIVE SYSTEM IN THE HIGH SCHOOLS.

The increase in the number and variety of courses offered by the high schools has necessarily led to an elective system parallel with that now so widely prevailing in our colleges. This throws the responsibility for training our youth in a large measure back again on the parents, who must themselves decide or allow their children to decide, with such advice as they can get from their teachers or friends, regarding a large part of the instruction they are to receive in the high school.

Until quite recently the agricultural population has apparently taken but little interest in the development of the high-school system. Unable to support high schools in their own communities, they have been content to send such of their children as they desired to have instruction in this grade to the high schools in the neighboring villages and cities. This they have done, either with set purpose to educate them for other pursuits than agriculture or without realizing that the education given in the high schools under existing conditions must necessarily tend to draw their children away from the farm. The real significance of this is only now beginning to dawn on the leaders of agricultural progress. Within the past few years, however, hopeful beginnings have been made of a movement to establish agricultural courses of high-school grade in a number of institutions in

different States. The agricultural colleges are leading in this movement, partly because they see that with the increase of agricultural students in the high schools their chances are improved for getting a much larger number of students in the college courses in agriculture, and partly because as friends of agricultural education they realize that something must be done to disseminate more widely a knowledge of the theory and practice of improved agriculture and to turn the tide of rural sentiment, especially among the young people, back toward the advantages of a country life.

STATUS OF THE HIGH SCHOOLS.

At this juncture it is very important that our farmers should understand the existing status of the high schools as regards industrial education—should appreciate what a forceful factor these schools have become in shaping the life work of intelligent and progressive young people—and should see what are both the advantages and the limitations of the education given in the schools of this grade. When they have some understanding of these general matters relating to the high schools they will have an intelligent basis for determining what place the teaching of agriculture should take in these schools.

Summing up this brief review of the development of the high schools in this country, it may be said that they are public institutions in which, along with ancient and modern languages, mathematics, history, and other so-called culture studies and the elements of natural sciences, the theory and practice of various industrial arts are being taught, especially those arts practiced in villages and cities. The instruction given in these schools goes far enough to make their graduates intelligent and progressive citizens and largely the leaders in industrial and political life in the local communities. They are not, however, fitted by the high schools for professional life, for careers as experts in the higher walks of technical, scientific, or artistic pursuits or for the broader achievements in the social or political world. For success in these higher walks of life most young people will need to go on to the college, technical school, and university. If agriculture is introduced into the high schools, it must not be expected that the graduates from such courses will ordinarily become agricultural experts in the highest sense. To achieve this they will need to attend the long courses in the agricultural colleges. As a result of pursuing agricultural courses in the high schools, they should, however, have an intelligent appreciation of the relation of science to agriculture; they should know something of the recent advancement in agricultural practice, and they should be able to take advantage of the information which the Department of Agriculture, the experiment stations, the agricultural press, and other agencies are constantly bringing to their attention. They should also have sufficient general culture

to make good homemakers and progressive citizens. And above all, they should have an intelligent appreciation of the advantages of country life.

AGRICULTURAL HIGH SCHOOLS AND SECONDARY COURSES IN AGRICULTURE.

It is believed that already enough successful experiments in the establishment of agricultural high schools and secondary courses have been made to demonstrate the feasibility and value of such schools and courses. The agencies for this work are of several different kinds, as follows: (1) High schools connected with agricultural colleges, as in Minnesota and Nebraska; (2) separate agricultural high schools endowed by the State, as in Wisconsin, Alabama, and California; (3) private agricultural schools, as in New York, New Jersey, Pennsylvania, and Indiana; (4) agricultural courses in normal schools, as in Missouri; (5) agricultural courses in public high schools.

SCHOOLS OF AGRICULTURE OF UNIVERSITIES OF MINNESOTA AND NEBRASKA.

The school of agriculture of the University of Minnesota was established in 1888. It is located at St. Anthony Park, between the cities of Minneapolis and St. Paul, on the grounds of the College of Agriculture of the same university. The equipment of the college is used by the school as far as its needs require. The university farm contains 250 acres of land, of which 140 acres are used for instruction and experiments in field, garden, orchard, and forest crops, and 50 acres are devoted to pasture. The buildings (Pl. LXIV) include those containing offices, library, and lecture rooms, dairy hall, chemical laboratory, veterinary building, horticulture building, drill hall, forge shop, power house, meat laboratory, barns for beef and dairy cattle and sheep, poultry and swine buildings, dormitories, girls' home buildings, and dining hall. There is a good equipment of apparatus and illustrative material. The agricultural library contains 6,000 books and about 6,000 pamphlets. The bulletins of the experiment stations and agricultural societies and a large number of technical and agricultural journals are regularly received. The faculty consists of about 35 men and women, including professors of the college and special instructors, among whom are experts in agronomy (plant production), animal husbandry, dairying, rural engineering, horticulture, forestry, dressing and curing meats, veterinary science, and agricultural physics, chemistry, and botany.

Students of both sexes are admitted. Applicants for admission are examined in English grammar, arithmetic, history of the United States, and geography, unless they present certificates showing they have completed the eighth-grade work in these subjects. The school term

opens October 1 and closes March 20. The course of study covers three years, and for the boys includes the following subjects:

Course of study in school of agriculture of University of Minnesota.

First year.	Second year.	Third year.
Music.	Music.	Music.
Gymnastics.	Gymnastics.	Gymnastics.
English.	Algebra.	Home economy.
Drawing.	Agricultural physics.	Geometry or civics.
Farm arithmetic.	Agricultural chemistry.	Entomology.
Agricultural botany.	Agronomy.	Zoology.
Comparative physiology.	Animal husbandry.	Agricultural chemistry.
Agronomy.	Dairying.	Agronomy.
Carpentry.	Horticulture.	Poultry culture.
Blacksmithing.	Military drill.	Animal husbandry.
Military drill.		Dressing and curing meats.
		Forestry.
		Veterinary science.

The girls substitute courses in domestic science and practice for the shopwork and a portion of the agriculture, but are required to take courses in field agriculture, horticulture, forestry, dairying, poultry culture, meats, and stock judging.

For young men, practical experience in field work at the university farm or elsewhere is among the requirements for graduation.

It is estimated that the total expenses of students for the school year need not exceed \$85, exclusive of board and personal expenses. Tuition is free, and text-books may be rented at \$1 per term.

The school has two distinct functions: "It offers a practical course of study designed to fit young men and young women for successful farm life and it serves as a preparatory school for the college of agriculture."

Regarding the success of this school, Prof. W. M. Hays, professor of agriculture in the University of Minnesota, writes as follows under date of October 30, 1902:

At present there are 410 students in the agricultural high-school course, and this probably means that we will have about 500 in this course during the year and between 200 and 300 in other courses.

The agricultural high school takes the boys and girls from the rural schools of Minnesota, gives them three or four years of six months each of instruction and experience, which is rather intense in its nature and appears to be very interesting to the young people. They live in dormitories, and I feel very certain that the influence of the country-life atmosphere pervading this school community causes the percentage to be considerably increased of those who at the end of the course intend to return to farm life as compared with that at the beginning of the school course. The students in their own intercourse are constantly magnifying the industrial, business, social, and general opportunities of country life. The farm, the farm home, and the farm community are being greatly enlarged in the minds of these young people. The wonderful wealth of material now available for a strong faculty to select from in placing subjects before students in an agricultural high school makes even a secondary course like this very broad in its scope.

A course made up of one-third industrial, one-third scientific, and one-third academic studies may properly be claimed as the broadest kind of a course for nearly all young people. Such a course not only gives a broad view of life, but it teaches how to think and to do. The larger percentage of people thus trained are able to gain the necessary means and position to enable them to afford facilities for continuing their education throughout their lives, no matter what their vocation. This is not true of those being educated in the narrower, so-called academic or literary lines in our city high schools.

Nearly all the graduates of the school of agriculture not only return to the farm, but generally succeed. Many of the young men are growing into leadership in their respective communities and many more by their quiet example are bringing about a more hopeful view of country life and farming, and are thus setting the pace for many neighbors. In some counties this influence is being clearly felt.

A school on essentially the same plan, but without the courses in domestic science, organized at the University of Nebraska, had an attendance of 118 boys in 1902.

AGRICULTURAL HIGH SCHOOLS IN WISCONSIN.

With a view to bringing secondary education in agriculture closer home to the farmers of different localities a movement has been begun for the establishment of county or district agricultural high schools. In Wisconsin the first two county agricultural schools have recently opened their doors to students. These schools are the outcome of a report made by Hon. L. D. Harvey, State superintendent of public instruction in Wisconsin in 1900. From his studies of the rural schools in this country, as compared with those in Europe, Mr. Harvey became convinced that as regards "instruction in the principles of agriculture in grades of schools below the agricultural colleges" "we are far behind foreign countries both in the scope of the work attempted and in the extent to which it has been organized." It did not seem to him feasible to introduce the teaching of agriculture into the common rural schools at present, owing largely to the lack of trained teachers. "Whenever we have in our rural schools," he says, "a body of professionally trained teachers who have had specific instruction in this subject and modes of teaching it, we may then hope to make some progress in the rural schools, but until then we must look elsewhere for this instruction." He therefore recommended that the State legislature should "provide for the establishment of county schools for instruction in agriculture and domestic economy." The legislature adopted this suggestion at its session in 1901 and passed a law authorizing the county board of any county "to appropriate money for the organization, equipment, and maintenance of a county school of agriculture and domestic economy," or "the county boards of two or more counties may unite in establishing such a school." The character of these schools is shown in the following sections of this act:

SECTION 6. In all county schools of agriculture and domestic economy organized under the provisions of this act instruction shall be given in the elements of agriculture, including instruction concerning the soil, the plant life, and the animal

life of the farm. A system of farm accounts shall also be taught. Instruction shall also be given in manual training and domestic economy and such other subjects as may be prescribed.

SEC. 7. Each such school shall have connected with it a tract of land suitable for purposes of experiment and demonstration, and not less than 3 acres in area.

SEC. 8. The schools organized under the provisions of this act shall be free to inhabitants of the county or counties contributing to their support who shall be qualified to pursue the course of study, provided they shall have at least the qualifications required for completion of the course of study for common schools. Whenever students of advanced age desire admission to the school during the winter months in sufficient number to warrant the organization of special classes for their instruction, such classes shall be organized and continued for such time as their attendance may make necessary.

These schools are by the law put under the general supervision of the State superintendent of public instruction, who, "with the advice of the dean of the College of Agriculture of the State University shall prescribe the courses of study to be pursued and determine the qualifications required of teachers employed in such schools. Upon the approval of the State superintendent the State will pay a share of "not to exceed one-half the amount actually expended for instruction in such school" in any county.

Two schools have already been established under this act.

The Marathon County School of Agriculture and Domestic Economy, located at Wausau, Wis., was opened October 6, 1902. (Pl. LXV, fig. 1.) The buildings and equipment provided for this school cost $20,000. The school grounds cover 6 acres. The course of study for boys includes soils, plants, animal husbandry, rural architecture, blacksmithing, carpentry, and mechanical drawing. The course of study for girls includes cooking, laundering, sewing, floriculture, and home management and decoration. Both courses include English language and literature, United States history, civil government, and commercial arithmetic, with farm accounts. Tuition is free to students living in Marathon County. The cost of board and rooms runs from $2.50 to $3 a week. On November 26, 1902, this school was reported to have 62 students—15 boys and 47 girls. The average age of the students was 16 years. The principal of the school is R. B. Johns, a graduate of the University of Wisconsin.

The other school is located at Menomonie and is known as the Dunn County School of Agriculture and Domestic Science. This school is centrally located in the county and is equipped with a fine brick main building erected by the county at a cost of $16,000 for the joint use of this school and the county teachers' training school, and a frame building for shopwork, which, with the grounds surrounding the school, cost $5,000. (Pl. LXV, fig. 2.) The farm work is done on the county asylum farm, 1 mile distant from the school.

The course of study for boys includes instruction regarding soils, fertilizers, plant life, horticulture, field crops, animal husbandry,

FIG. 1.—MINNESOTA SCHOOL OF AGRICULTURE—LIBRARY AND HOME BUILDING FOR BOYS.

FIG. 2.—MINNESOTA SCHOOL OF AGRICULTURE—DAIRY HALL.

FIG. 1.—MAIN BUILDING OF THE MARATHON COUNTY SCHOOL OF AGRICULTURE AND DOMESTIC ECONOMY, WAUSAU, WIS.

FIG. 2.—MAIN BUILDING OF THE DUNN COUNTY SCHOOL OF AGRICULTURE AND DOMESTIC SCIENCE, MENOMONIE, WIS.

dairying, poultry, economic insects, farm accounts, blacksmithing and other metal work, carpentry, and rural architecture.

The course of study for girls includes work in sewing, cooking, home economy and management, drawing and designing, domestic hygiene, chemistry of foods, poultry, farm accounts, and horticulture.

Both courses include studies in civil government, United States history, library readings, English, and elementary science.

Only two years will be required to complete the full course for either boys or girls, and shorter courses may be pursued.

Tuition is free to students living in Dunn County. Others will pay $25 per year, except that the first 10 students from other counties will be admitted for the first year on the payment of only $10 each.

Students may find board and rooms in private families in Menomonie at prices ranging from $2.25 to $3.75 per week. Students can board themselves for about $2 per week.

The school opened October 20, 1902, and by December 44 students had registered (32 boys and 12 girls), of an average age of 18½ years. They are from the country schools with few exceptions. The principal of the school is Dr. K. C. Davis, a graduate of the Kansas Agricultural College, and recently horticulturist of the West Virginia Agricultural Experiment Station. He pursued post-graduate studies in agriculture at Cornell University, where he received the degree of doctor of philosophy.

It is interesting to observe that this county agricultural high school is joined to a school especially established for the training of teachers for the country schools. In this way many teachers will be brought into sympathy with the movement for the introduction of agriculture into the public-school system and many elementary country schools will be recruiting stations for the agricultural high schools.

AGRICULTURAL SCHOOLS IN ALABAMA, CALIFORNIA, AND MISSOURI.

In 1896 the legislature of Alabama provided for the establishment of agricultural schools in each of the nine Congressional districts of the State and appropriated $2,500 a year to each of these schools, which is supplemented by local funds. As actually established, these schools have been a combination of elementary and high schools in which a general education has been given with a limited amount of instruction in agriculture. Farms are connected with the schools, on which, in some cases, simple field experiments have been conducted. Over 2,000 boys and girls annually attend these schools, several hundred of whom receive some instruction in agriculture. These schools have been largely under local control, with the result that there has been no well-defined plan for their development along agricultural lines. With a better understanding of the requirements and advantages of systematic instruction in agriculture they may easily be developed into efficient agricultural high schools.

In California a State appropriation has been made for a polytechnic school to be located at San Luis Obispo in which agricultural education of secondary grade will be a leading feature. Plans are being made for the opening of this school at an early day.

In order to prepare teachers to give instruction in agriculture in the public schools of the State, short courses in agriculture and horticulture have been given at summer schools held in connection with the University of Missouri. These courses were, however, necessarily too limited in extent to fully meet the requirements of such work, and courses in agriculture have therefore been established in the three normal schools of the State. At the normal school at Kirksville, Mo., the course in agriculture occupies one school year of nine and one-half months, five recitation periods a week being devoted to this subject. The topics included in the course are soils, fertilizers, rotation of crops, propagation of plants, plant breeding, pruning, grafting, insects and insecticides, spraying, and dairying, with brief consideration of matters relating to forestry. At the normal school at Warrensburg, Mo., only twenty weeks have been given to the agricultural course, but it will probably be lengthened in the future. One hundred and eighty-five students have completed this course and 104 are enrolled the current year.

At the normal school at Cape Girardeau, Mo., forty weeks are given to instruction in agriculture. King on the Soil and Goff's Principles of Plant Culture are used as text-books. These are supplemented by lectures on dairying, injurious insects, and plant diseases. Eighty students elected this agricultural course in 1902.

AGRICULTURAL SCHOOLS FOR NEGROES IN THE SOUTHERN STATES.

Courses in agriculture of approximately high-school grade are maintained in a number of schools for negroes in the Southern States. The Normal and Agricultural Institute, at Hampton, Va., has a well-organized course of this character. A considerable number of the students in the institute have previously attended the elementary school, known as the Whittier School, which is a public county school located on the grounds of the institute and furnished by it with teachers. It is a practice school for the normal students in the institute and includes a kindergarten and five grades. Its entire curriculum is adapted to industrial schemes followed in the institute. Even in the kindergarten the children not only have their games, songs, and paper cutting, but also learn to dust furniture, water plants, and do other useful tasks. All the boys and girls in this school, from the kindergarten up, have nature study, comprising elementary studies in plant life, soils, and insects, and work in a garden attached to the school during two forty-minute periods each week. There they learn to use hand tools and large farm implements, the preparation of the soil, and the planting, cultivation, and harvesting of vegetables, fruits, flowers, and farm crops.

At the institute the regular course, which is given in a day school, covers the studies ordinarily taught from the sixth to the ninth grades, inclusive, and occupies three years. Pupils who have no funds may attend a night school to prepare themselves for the day school, meanwhile earning money by farm work during the day. Instruction in agriculture is given in both the day and night schools. Besides the grounds about the institute there is an estate of 600 acres, known as the Hemenway farm, 5 miles from Hampton, on which are maintained a herd of nearly a hundred dairy cows and large flocks of chickens, ducks, geese, and turkeys. The foreman's residence is the old plantation mansion dating back to the middle of the seventeenth century. In a new wing of this building there is a class room for the night students who work on the farm. A new dairy barn is now being erected. This farm is run on a practical basis, and, in addition to furnishing work to night students, supplies many things for the institute table and for the general market.

At the institute in Hampton 20 acres of land are devoted especially to the practice work of the agricultural students. Four acres of this have been laid out as a small model farm, 10 acres have been planted with orchard fruits, and the remainder is used for experiments and demonstrations in growing farm truck and garden crops. In the new domestic-science building the department of agriculture has six large rooms—a museum and lecture room, laboratories for agriculture, chemistry, and physics, one for botany, horticulture, and entomology, a dairy, and a farm-engineering room. There are also two greenhouses. The dairy is well equipped for creamery work and farm dairying, and the farm-engineering room contains a collection of plows, harrows, drills, and other farm machinery.

The regular course includes instruction in soils, plant production, animal industry, dairying, drainage, and farm management. A supplementary course is offered to those intending to fit themselves to be agricultural teachers or farm superintendents. Mr. C. L. Goodrich is at the head of this department and the present year has the assistance of two graduates of Cornell University.

Agricultural courses on substantially the same plan are conducted at Booker Washington's Institute at Tuskegee, Ala., where the work is in charge of Mr. G. W. Carver, a graduate of the Iowa Agricultural College. Among the other schools for negroes where successful agricultural courses are maintained are the Agricultural and Mechanical College for Negroes, Normal, Ala.; State College for Colored Students, Dover, Del.; Florida State Normal and Industrial College, Tallahassee, Fla.; Georgia State Industrial College, College, Ga.; State Normal School for Colored Persons, Frankfort, Ky.; Southern University and Agricultural and Mechanical College, New Orleans, La.; Alcorn Agricultural and Mechanical College, West Side, Miss.; Agricultural and Mechanical College for the Colored Race, Greensboro, N. C.; the

Colored Normal, Industrial, Agricultural, and Mechanical College of South Carolina, Orangeburg; West Virginia Colored Institute, Institute, W. Va.

SECONDARY AGRICULTURAL INSTRUCTION IN STATE COLLEGES AND PRIVATE SCHOOLS.

At a number of the State agricultural colleges students are received directly from the common schools and are given secondary instruction in agriculture and other subjects in preparatory or other courses. The present tendency is to differentiate these lower courses more distinctly from the regular college course and to raise the requirements for the bachelor's degree. A good illustration of this tendency is furnished by the recent programme of the Connecticut Agricultural College. This provides a four years' course of "preparation for farming," which is essentially an agricultural high-school course and is open to students from the common schools who will receive a special diploma but no degree on graduation. To obtain the degree of B. S. at least two years' further study at the college will be required. It is noteworthy that most of the agricultural students at this institution are enrolled in the secondary course.

Within the past few years a number of private agricultural schools of secondary grade have been established. One of the most successful of these institutions is the National Farm School, at Doylestown, Pa. This school was established in 1896, and is supported by private donations, sales of farm products, and tuition fees. A State appropriation of $2,500 a year for two years became available in 1901. The equipment consists of a farm of 122 acres, main building containing dormitories and class rooms, chemical laboratory, dairy building, barns, greenhouses, and live stock. The course of study covers four years and includes the English, mathematics, and natural sciences usually taught in a high school, together with a considerable amount of instruction in the science and practice of agriculture. The students, who are largely drawn from cities, reside at the school during the entire year and perform a large part of the labor necessary to carry on the farm. About forty boys are in attendance the present year, which is as many as the school can now accommodate. The first class, consisting of eight boys, was graduated in 1901. Six of this number are employed on farms, and two have been assistants in the Bureau of Soils of the Department of Agriculture.

A similar school is the Baron De Hirsch Agricultural School, established in 1891 at Woodbine, N. J.

A secondary school, known as the Winona Agricultural and Technical Institute, has recently been established at Winona Lake, Ind.

A school of practical agriculture and horticulture has been in successful operation for over two years at Briarcliff Manor, N. Y. This school was established "to ascertain the public demand for an

institution giving attention to the training of young men and women, especially of the cities, in the practice of agriculture, to enable them to obtain an independent livelihood and at the same time to develop a taste for rural life, by demonstrating that higher value may be obtained from land by intelligent management than under methods now generally practiced." Each student was required to perform a considerable amount of work on the farm and in the orchard, garden, and greenhouse. The regular course of study covered two years and included instruction in botany, chemistry, geology, physics, agricultural zoology, entomology, meteorology, surveying, and bookkeeping, and the different branches of agriculture and horticulture.

The school soon outgrew its limited facilities at Briarcliff Manor, and plans were made for removing it in the spring of 1903 to a farm of 425 acres near Poughkeepsie, N. Y. But the officials in charge of the school have been unable to procure adequate endowment for its support and have therefore decided to abandon the enterprise. This is much to be regretted, since the history of this enterprise shows that there is a demand for education of this kind, and the school occupied a place which is not fully filled by any other institution.

SUGGESTIONS FOR COURSES IN AGRICULTURE IN THE PUBLIC HIGH SCHOOLS.

In addition to special agricultural high schools under State or county control, it is believed that the public high schools in or near the rural communities should offer courses of instruction in agriculture. Here and there attempts are being made to teach agricultural subjects in such schools, but thus far there has been no organized effort in this direction. In order to point out the feasibility of introducing agricultural courses into the high-school programmes, the committee on methods of teaching agriculture of the Association of American Agricultural Colleges and Experiment Stations, in its report to the convention of the association held at Atlanta, Ga., in October, 1892, outlined a number of high-school courses in which agricultural topics were included. The following statements are taken from that report:

> Agriculture has thus far been almost entirely neglected in the high-school programmes, and it is high time that the friends of agricultural education should make a systematic effort to have the claims of this fundamental industry acknowledged and satisfied in the curricula of the public high schools. Since successful agriculture is essential to the prosperity and well-being of urban as well as rural communities, there should be cooperation between country districts, villages, cities, and the States to provide the means for the maintenance of agricultural courses in the high schools. As a practical measure, it is believed that such courses may be added to those already existing in many high schools by the addition of a single teacher, who should be an agricultural college graduate, to the teaching force already supplied. The expense of maintaining this teacher and his equipment may properly be shared by the State, the village, or city maintaining the high school and the country district from which the pupils from the farms are drawn to this school. The State may properly aid this movement by offering a stated sum annually to high schools maintaining agricultural courses. Already many small townships are paying the tuition of pupils attending high schools in

neighboring townships, and this system should be extended, with the proviso that such tuition fees paid for students desiring agricultural courses should be devoted to the maintenance of agricultural courses. The balance necessary to maintain these courses will, it is believed, be cheerfully paid by the villages or cities maintaining the high schools as soon as they realize that such expenditure is in the nature of an investment, the returns from which in the way of better and more abundant agricultural products will be certain and remunerative.

In order that it may be apparent that agricultural courses may be offered in the high schools without any violent or radical reorganization of existing programmes for such schools, a number of tentative schedules for such courses are presented along with various courses already existing in high schools in different parts of the country. An examination of numerous high-school programmes has revealed a very great variety in their courses as regards the number of different branches and the amount of time devoted to each branch in any particular course. In general, however, it may be said that the average high-school course in this country presupposes that the student has had an eight-year course in a primary school, where he has been taught reading, writing, spelling, arithmetic, elements of English grammar and composition, geography, and United States history. The best primary schools also give some instruction in drawing, music, nature study, and woodworking, or sewing and cooking. The high-school course covers four years and will ordinarily embrace instruction in algebra, geometry, ancient and modern history, English, drawing, and music, together with various combinations of Latin, Greek, French, German, and the elements of natural sciences (especially chemistry, physics, and botany). Whenever the manual arts or the natural sciences are largely introduced into high-school courses the practical effect is to reduce the amount of time given to the ancient and modern languages. With improved instruction in English and science the effect of this on the general training of the student is not as marked as it might otherwise be, and whatever the theoretical pedagogical value of instruction in ancient or modern languages, there is little doubt that when a choice has to be made between these subjects and those which relate directly to the pursuit by which the pupil is to gain his livelihood, it will in most cases be desirable that he shall choose the things of most direct benefit in his life work. That it will not always be necessary for the student of agriculture to entirely neglect the study of at least one ancient or modern language in this high-school course, provided his tastes or attainments lead him in that direction, may be seen from examination of the programmes of courses presented.

With the introduction of agriculture into the high-school course it is presumed that the courses in physics, chemistry, botany, and zoology will be so shaped as to form an appropriate introduction to the more formal instruction in the different branches of agriculture, that is, agronomy, zootechny, dairying, rural engineering, and rural economy. As indicated in previous reports of this committee, we would include under agronomy whatever is taught regarding climate, soils, fertilizers, and the botany, varieties, culture, harvesting, preservation, uses, and enemies of farm crops; under zootechny, the theory and practice of animal production, including the breeding, feeding, hygiene, and management of farm animals; under dairying, the principles and methods involved in the handling and sale of milk for consumption, and in the making of butter and cheese; under rural engineering, principles and methods involved in the laying out of farms and the construction and use of farm buildings, systems for water supply, irrigation, drainage, sewerage, roads, and machinery; under rural economy, the history of agriculture, capital, labor systems, cost of production, marketing, records, accounts, etc., as related to farm management.

As an example of the simpler forms of high-school courses, the committee printed the following programme, prepared under the direction

of the State superintendent of public instruction in Indiana, and recommended it for use in that State in high schools where at least two teachers are employed exclusively in high-school work, and along with this a tentative agricultural course prepared by the committee, which presupposes an additional teacher:

Programme for high schools in Indiana.

FIRST YEAR.

General course.	Weekly recitations.	Tentative agricultural course.	Weekly recitations.
Algebra	5	English	5
English	5	Algebra	5
Latin	5	Plants and their cultivation (i. e., botany—general and economic)	5
Physics or chemistry	5	Physics	5

SECOND YEAR.

General course.	Weekly recitations.	Tentative agricultural course.	Weekly recitations.
Algebra (one-third year)	5	English	5
Geometry (two-thirds year)	5	Algebra Geometry	5
English	5	Animals and their management (i. e., zoology—general and economic)	5
Latin	5	Chemistry	5
History	5		

THIRD YEAR.

General course.	Weekly recitations.	Tentative agricultural course.	Weekly recitations.
Geometry (two-thirds year)	5	English	5
Elective[a] (one-third year)	5	Geometry, Latin, or German	5
English	5	Agronomy (with special attention to local crops)	5
History	5	History	5

FOURTH YEAR.

General course.	Weekly recitations.	Tentative agricultural course.	Weekly recitations.
Elective[a]	5	History	5
Zoology or botany	5	Political economy	5
Latin	5	Zootechny and dairying	5
History	5	Latin or German	5

[a] Mathematics, physical geography, oratory, or advanced physiology.

With the introduction of agriculture into high schools of this kind the division of studies among three teachers might be as follows:

A.	B.	C.
English.	Chemistry.	Physics.
Latin.	Botany.	Mathematics.
German.	Zoology.	History.
	Agriculture.	Political Economy.

Teacher B should be an agricultural-college graduate and would ordinarily be a man who might be principal of the school. Teachers A and C would ordinarily be women.

The committee also published programmes illustrating high-school courses in some of the larger cities. The following from the Lowell,

Mass., High School shows how an agricultural course might be introduced into the curriculum of a school which gives pupils a choice between a number of different courses. Eight courses are offered, but only the three recommended as general training courses are given herewith. Studies in *italics* are elective.

Programme of Lowell, Mass., High School.[a]

Classical course.		Modern-language course.		Manual-training course.		Tentative agricultural course.	
FIRST YEAR.							
English	5	English	5	English	5	English	5
Algebra	5	Latin	5	Algebra	5	Algebra	5
Latin	5	Algebra	5	Manual training	5	Plants and their cultivation (i. e., botany — general and economic)	5
Physical geography	2½	*Physical geography*	2½	*Physical geography*	2½	Physics	2½
SECOND YEAR.							
History and English	5	History and English	5	History and English	5	History and English	5
Geometry	5	Physics	5	Manual training	5	Animals and their management (i. e., zoology—general and economic)	5
Physics	5	*Geometry*	5	*Geometry*	5	*Chemistry*	5
Latin or *French*	5	*French*	5	*Physics*	5	*Geometry*	5
				French	5	*French* or *Latin*	5
THIRD YEAR.							
History and English	5	History and English	5	History and English	5	History and English	5
Arithmetic	2½	*Arithmetic*	2½	Manual training	5	Agronomy and rural engineering	5
Physiology	2½	*Physiology*	2½	*Arithmetic*	2½	*Arithmetic*	2½
Chemistry	2½	*Chemistry*	2½	*Physiology*	2½	*Physiology*	2½
German	5	*German*	5	*Chemistry*	5	*Chemistry*	5
Latin	5	*French*	5	*German*	5	*French* or *German* or *Latin*[c]	5
Astronomy and *geology*[b]	5	*Astronomy* and *geology*[b]	5	*French*	5	*Astronomy* and *geology*[b]	5
				Astronomy and *geology*[b]	5		
FOURTH YEAR.							
English	5	English	5	English	5	English	5
History	5	*History*	5	Manual training	5	Zootechny and dairying	5
Chemistry	5	*Chemistry*	5	*History*	5	*History*	5
German	5	*German*	5	*Chemistry*	5	*Rural economy* and *farm management*	2½
Latin	5	*Botany*	2½	*German*	5	*Entomology*	2½
Botany	2½			*French*	5	*Trigonometry* and *surveying*	5
				Geometry and *trigonometry*	5		

[a] The figure opposite each study indicates the number of recitations per week.
[b] May be taken the fourth year instead of the third.
[c] Whatever language is elected should be continued through at least two years.

CONCLUSION.

Now that a real beginning of secondary education in agriculture suited to American conditions has been made and some success has been attained, there is needed a considerable number of experiments in this direction before it will be possible to fix anything like a standard for schools of this class. One very important consideration is the nice adjustment of the culture and industrial studies so that the general education of the pupil will not be neglected while he is at the same time being trained for the successful practice of agriculture. In arranging such courses it must ever be kept in mind that as a man, citizen, and home maker the farmer needs the same training as other men. To make narrowly educated money makers in our public schools would be ruinous to the best interests of the country and mankind. All the objects of education, as defined by President Eliot of Harvard University, who is now president of the National Educational Association, must, if possible, be attained by the public high schools. That is, "we must learn to see straight and clear; to compare and infer; to make an accurate record; to remember; to express our thought with precision; and to hold fast on lofty ideals."

It is believed that the introduction of effective courses in agriculture into these schools will strengthen them in all these directions if the courses are properly arranged and taught.

At present the problem of obtaining properly qualified teachers is a serious one. Most of the teachers now employed in the public high schools have been trained in literary and scientific institutions or in technical schools where no agriculture has been taught. It is only now and then that a teacher is found who is in real sympathy with agricultural education. Attention must, therefore, be directed to the fitting of teachers for this work in the agricultural colleges. Text-books on agricultural subjects suitable for secondary schools are almost entirely lacking. These, however, will be supplied as fast as the demand for them arises, and they will be improved as experience shows their deficiencies. The friends of agricultural education should realize that we are in the period of experiment and missionary effort in this movement. What is especially needed now is an organized propaganda through the agricultural colleges, agricultural societies, boards of agriculture, farmers' institutes, the agricultural press, and other agencies with a view to impressing on school officers and teachers and on the agricultural masses the importance and desirability of giving serious and active attention to this matter. Every successful effort to maintain an agricultural high school or an agricultural course in a public high school will add great momentum to this movement.

A great gain has been made in that there is now seen the real nature of the problems to be solved in order to secure an efficient system of secondary courses in agriculture as a part of the public-school system.

Active work along this line will now most surely bring valuable results. When the advantages to be derived from such courses in agriculture in the high schools are once clearly demonstrated in a few places it will not be difficult to persuade the taxpayers generally to contribute the necessary funds for their maintenance.

The writer went not long ago to a flourishing agricultural community, in the midst of which was a fine and wealthy city. On invitation of leading citizens he went to the splendid high-school building in that city and addressed the teachers and students. In that school were gathered some 600 active and intelligent American boys and girls. They were pursuing courses in English and other languages, mathematics, history, political economy, and a number of natural sciences. With much justifiable pride the principal showed his visitor the good equipment for work in carpentry and wood carving. There was also instruction in various forms of commercial business. But agriculture and horticulture were entirely neglected. The farms and horticultural plantations surrounding that city aggregated millions of dollars in value. The prosperity, if not the very existence, of the city depended on the success of the agriculture in its vicinity. Grave evils afflicted that agricultural region, the removal of which will require much intelligence and expert skill. Hundreds of the pupils attending that high school would naturally, if not necessarily, make agriculture in that region the business of their lives. And yet no pupil of that school was learning anything about the requirements of successful agriculture or the aid which science may give the farmer in his struggle with the forces of nature vitally affecting his business. The whole drift of the education given in that school was away from the farm. Could anything be more unwise? Is it not absolutely certain that, considered merely as a matter of business policy, the taxpayers of that city could well afford to pay all the additional expense which would be required to maintain courses in agriculture in that school? Undoubtedly the farmers of the vicinity ought to share in this expense, and there is good reason to expect they would do so.

There are hundreds of American communities where a similar state of things exists. It is not a matter of interest and concern to the farmers alone. The enduring prosperity of cities is inextricably bound up with the success of agriculture. Technical education has proved a sure road to commercial development and greatly increased wealth in connection with every industry which has received its benefits. It will prove equally so as regards agriculture. The tremendously productive results which have already come from the work of the agricultural colleges and experiment stations may be multiplied a hundredfold by the education of hundreds of thousands of the flower of rural youth in secondary schools in which there is definite and systematic teaching of the technique and scientific principles of agriculture.

PLANTS AS A FACTOR IN HOME ADORNMENT.

By L. C. Corbett,
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INTRODUCTION.

The object of the present paper is, if possible, to leave a thought in the mind of the reader which will develop into a love for natural objects—a sentiment which will carry with it a desire to see all portions of mother earth clothed in her normal raiment of green grass and graceful trees, which will stimulate a friendship with these natural objects, so that they shall be made our neighbors and our companions.

Trees possess an individuality as markedly their own as do persons. Trees which have become familiar objects, landmarks, carry their history engraven on their trunks and branches. One scar tells the story of the path through the primeval forest, another notes the point where the possessions of families well known in early history join, while a split trunk or a broken limb may record the occurrence of some memorable storm. All are familiar with trees which have associations of this sort, and all consider them important objects. So it will be with the trees one plants. Children and grandchildren will point to them as objects of interest; for, as Addison says:

> Plantations have one advantage in them which is not to be found in most other works, as they give a pleasure of a more lasting date and continually improve in the eye of the planter. When you have finished a building or any other undertaking of the like nature it immediately begins to decay on your hands. You see it brought to its utmost point of perfection, and from that time hastening to its ruin. On the contrary, when you have finished your plantations they are still arriving at greater degrees of perfection as long as you live, and appear more delightful in each succeeding year than they did in the foregoing.

THE ÆSTHETIC VALUE OF PLANTS.

The appropriate use of flowers, shrubs, and trees in the adornment of city, village, and suburban home areas is worthy of our best efforts. Upon it depend a charm and beauty which not only please and elevate the passer-by, but the occupant of the home as well. To the observer some of the spirit and beauty of the home is portrayed in its outward embellishments. Trees and shrubs afford not only a means of expressing restfulness and beauty, but they possess in themselves these attributes. The ever-changing aspect presented by a plant during the

succession of the seasons is a source of pleasure, and each expression is appropriate for the season. In fact it is these manifestations of youth, fruition, and decay in the plant which symbolize in the human mind the ideas of life in various stages, as manifested by the metaphoric use of the words "spring," "summer," and "autumn" to symbolize the three stages of life. It is these beautiful manifestations of the wonders of nature in flowers, shrubs, and trees that give to them their charm and their appropriateness for use about our homes, our schools, and our churches. Every leaf, every branch, and every flower manifests a type of beauty which art has always endeavored to approach. But at best the pen and the brush can portray nature's handiwork in a weak and unsatisfactory manner. While art can not take the place of nature, art nevertheless plays an important rôle in teaching us to see that at which we look. After the eye has been trained to see and the mind to interpret the beauties which the eye beholds, then association with nature produces its greatest effect.

Nature is our most valuable instructor. She teaches the use of grass, of trees, of shrubs, and of flowers. She combines them in most pleasing and harmonious groups and masses, but never in a harsh or monotonous fashion. The requirements of plants of various kinds have been so adjusted that trees, shrubs, and vines, as well as herbaceous annuals, form a pleasing and profitable copartnership. Nature abhors galls and sores upon the face of the earth and has so modified plants that, if man did but know it, there is one suited to occupy every inch of arable soil. The procession of plant life which inhabits any given area through successive years and even during the different seasons is interesting. Each preceding generation provides improved conditions for the brood to follow, and so on from season to season and from year to year until the plant life of an area has passed through the several stages from the simple lichen and moss to the most complex of the flowering plants; as this development takes place the land is reclaimed and reclothed; harmony and beauty follow ruin and desolation. Plants are worthy of attention, therefore, for the lessons which they teach as well as for their beauty.

The wisdom accredited to the ant is equally manifested by plants; each generation provides for the one which is to follow. Not only this, but if a more comprehensive view of nature is taken the plant is found to be the master builder; all animal life is more or less directly dependent upon the plant.

THE PLANTING OF A PLACE.

The work of a nation as of an individual is to provide first for its necessities and then for its comforts and pleasures. Up to the present the American people as a people have been concerned with acquiring lands and building houses. Now that this has been accomplished, it is no more than might naturally be expected that the owners of lands

and houses should turn their attention to the embellishment of their grounds, in order that the picture they have drawn should have an appropriate setting. In the planting of a place, however, we have a much wider and broader collection of material to choose from than in the case of a picture to be framed. For this reason the peculiarities of the place as well as site, exposure, and soil conditions must all be taken into consideration in providing its decoration. Then, too, the object to be accomplished must be kept constantly in mind in order to produce a pleasing result. The first essential, therefore, in the development of a place is a design or working plan. This may follow either of two broad lines; it can be formal or it can be free and natural. But while there are these two primary ideas, either of which can be used in the development of a place, there is an appropriate use of each, which can be expressed in a general way. Small places, consisting of an acre or less, situated among others of like dimensions, if treated individually can only be appropriately improved in a formal style. On the other hand, large suburban places or country seats should, in order to maintain unity and harmony with their surroundings, be treated in the natural style of which they are a part. It is impossible to develop a forest, a park, or even a grove on an area less than an acre in extent, and it is equally impossible to maintain fountains, terraces, sheared trees, hedges, and carpet bedding over an area of several acres. These two general principles of planting have been developed to meet the needs of the two conditions.

In the references above made to the character of planting employed in the two styles of landscape gardening it must be borne in mind that extremes are indulged in for purposes of effect. A place which is classed as formally treated from the viewpoint of this paper would have been considered a discredit to that style two centuries ago, and in reality it is not deserving of the title of formal as recognized in garden lore. But because a balanced or formal effect is produced with straight walks and drives, which are admissible on small places alone, this style is called formal, although pruned trees and carpet bedding are neither of them factors in its composition.

PLANTING PLAN.

Before a tree or shrub is placed in its permanent location an outline map of the area to be treated should be made. This map should locate all existing structures, indicate the direction in which most pleasing outlooks are to be had, and also the contour of the ground to be treated. The aim should be to hide all objectionable buildings or portions of a place and to shut out by planting on one's own ground all unsightly objects maintained by neighbors; also to locate the trees and shrubs so as to allow the line of vision an uninterrupted sweep where the outlook is pleasing; to so locate the plantings on large estates as to afford the greatest possible protection consistent with

good landscape effect. It is impossible to illustrate by concrete examples all that is intended by the above statements. Fig. 44 will serve to illustrate what is meant by the use of shrubs and trees for protective as well as for screening or cover purposes. The groups marked *M* and *N* are for the purpose of hiding buildings which, while not seriously bad in themselves, contribute nothing to the general effect of the ground under treatment. Group *K* serves the double purpose of a bay plantation for the curved drive as well as a screen for the stable and workshop, while groups *E* and *F* are designed as covers or screens for the woodshed at the rear of the residence.

FIG. 44.—House lot for farm or estate: 1 to 9, Pin oaks; 10 to 12, Ginkgo biloba; 13, Willow Oak; 14 to 16, Norway maples; 17 and 19, Red oaks; 18, Elm; 25 and 27, Norway maples; 26 and 30, Tulip trees; 28 and 31, Red oaks; 29 and 32, Pin oaks; 33 and 34, Elms; 35 and 37, Green Ash; 36 and 38, Black walnuts; 39, Red Oak; 40, Elm; 41 to 45, Picea alba or Picea pungens.

Where trees and shrubs are needed neither as screens nor windbreaks their disposition should be such as will afford a pleasing effect and at the same time preserve as large an area of unbroken greensward as practicable. At the right in fig. 44 the area bounded by the curved drive is an unbroken lawn, with trees and shrubs disposed along the margins. On the left, however, the plantations have assumed the character of a grove in order to hide undesirable features in that quarter and for the purpose of serving as a wind-break.

WALKS AND DRIVES.

All walks and drives on small lots should be direct, as shown in fig. 45. The planting of trees and shrubs or the placing of fountains and flag

poles in the course of a walk which will cause the traveler to deviate unduly from his natural course is a common but objectionable arrangement. On small areas walks and drives should be straight unless there be good reason, because of the contour of the surface, for making them curved. In more extensive areas, where the grouping of shrubs becomes an important factor in the construction of the place, curved walks and drives are most pleasing and effective.

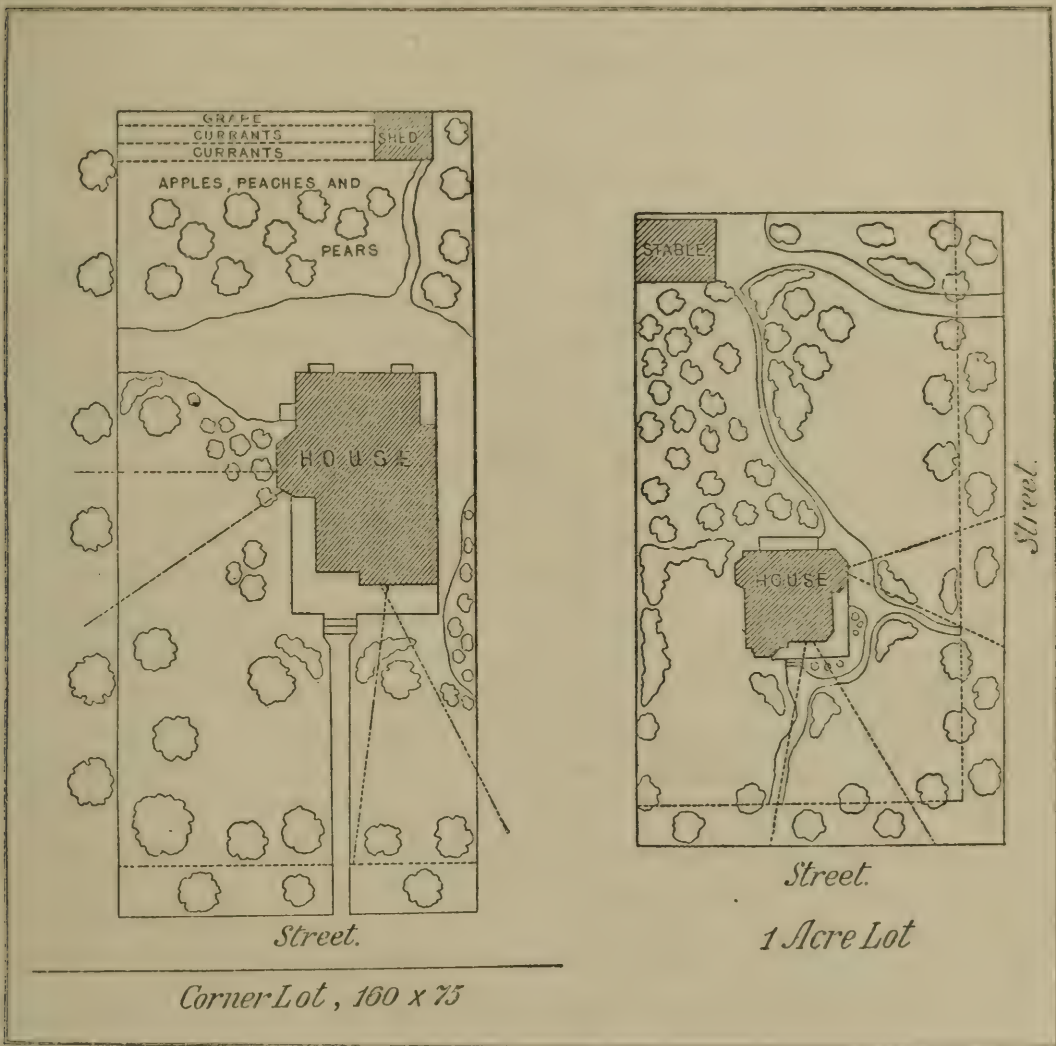

FIG. 45.—Planting plans for city lots: Irregular outlines and smaller circular figures represent groups of shrubbery; large circular forms show position of ornamental shade trees. In the plan of the acre-lot the plantation between the house and stable provides for a home fruit garden.

THE GREENSWARD.

With trees, shrubs, vines, and herbaceous bedding plants, pleasing contrasts can be produced. Each plant or group of plants has an expression peculiarly its own, and when used with suitable surroundings the effect is pleasing. While each of these plants possesses an intrinsic decorative value, this value is enhanced in proportion to the perfection of the greensward in which it is set. Green grass is not only useful as a covering for the earth, but it is of itself beautiful. A perfect lawn is one of the rarest possessions either of public or

private establishments. A good lawn demands great skill and judgment in its making as well as in its maintenance. The difficulties of lawn making become more accentuated as the heavy clays and clay loams of the North and West are replaced by the light, sandy soils of the South. The superb Kentucky bluegrass, which produces such perfect lawns in regions with heavy soils and abundant rainfall, must be supplemented by white clover as the soils become light and sandy, and finally, as southern latitudes are reached, both these must be replaced by Bermuda grass (*Capriola dactylon*) or by St. Augustine grass (*Stenotaphrum dimidiatum*).

The chief charm of a lawn consists in an even stand of grass of uniform color kept closely mown. In order to secure this a pure grass, such as Kentucky bluegrass, must be used, or the mixture must be so perfectly made from grasses of like habit of growth and coloring that a mottled effect will be avoided. For permanence, a greensward consisting of a blend of grasses is superior to one made from a single sort. For this reason, therefore, lawn mixtures usually consist of a number of different species and even genera. The great difficulty, however, lies in securing good germination from such mixtures, with uniform lawns as a result. The fescues all grow in stools or bunches; the rye grasses are lighter in color, coarse in leaf, and of more rapid growth than the Poas or bluegrasses. Most satisfactory combinations, both as regards beauty and permanence, come from mixing redtop and bluegrass (*Poa pratensis*). For poor soils containing much sand, the white Dutch clover is most satisfactorily used in combination with bluegrass and redtop.

In the South, however, lawns can only be successfully made from turf or from root stalks. The grasses which succeed in the North and are there comparatively easily grown from seeds are not successful in the South. Grasses which develop underground stems are most successful under southern conditions.

GENERAL ARRANGEMENT OF SHRUBS AND TREES.

In general, trees should stand either as specimen trees in isolated positions or in irregular groups rather than in long rows. Under certain conditions long avenues of trees regularly disposed on either side of a prominent drive or vista may contribute a very pleasing and imposing effect to a large place. The general rule for trees also applies to shrubs, except that their use should be chiefly in groups or belts rather than as specimen plants, although specimen plants are of value in formal plantations. Few shrubs possess a sufficiently graceful and characteristic habit of growth to make them pleasing objects when grown singly upon the lawn, but where a number of specimens of varying habit are brought together in a single group the differences are emphasized by contrast and the variety produces a pleasing effect, particularly if the rate and habit of growth as well as the color and

character of the foliage of the shrubs so combined be somewhat different. Pleasing results in groups of shrubs do not come from large numbers of the same variety in mass, but from a harmonious arrangement of different genera, species, and varieties. In order to secure the greatest pleasure from shrubs in groups, each group should represent some idea either of spirit or of rest, and at all times beauty. These effects come from the habit of growth of the plants used. Tall-growing, graceful, reed-like plants produce an effect of grace and beauty, while plants of a more sturdy habit may indicate strength and resistance. The latter are well suited for wind-breaks or shelter belts, while the former lend themselves to the formation of screens or masks, either for walks or drives or for fences or unsightly buildings.

Pleasing effects in shrubbery plantations come also from massing sorts so as to produce a floral display each month of the year. A group which blooms in May or June, and which presents no additional feature other than being a mass of foliage from June until autumn, has little merit from a decorative point of view. Variety is the secret of pleasing effects in shrubbery groups. Glaring contrasts in habit of growth or in color of flowers or foliage are as objectionable in planted groups as in tapestries, but reasonable and harmonious contrasts only add beauty and variety to the landscape. Not only do the flowers and foliage of spring and summer contribute to these results, but autumn colors add a most desirable and valuable contribution to the seasons' panorama.

Shrubs should be studied not alone from the standpoint of the size, color, and profusion of their bloom, but the season of leafing in relation to the size, color, and time of blooming should be noted. The color of the leaf during summer as well as in autumn is also important. But most important of all is the time the leaves fall, whether early or late, or whether they remain on all winter. Some shrubs retain their foliage well on into winter, while others, such as the California privet and many of the berberries, retain it all winter. Some of the magnolias retain their large glossy leaves until the approach of spring, when they turn brown and fall, to be replaced a few weeks later by a new set equally as large and glossy. In this connection, it is interesting to note a feature in our oaks and beeches which has some value from a decorative standpoint. Several of the oaks, notably *Quercus alba*, hold their leaves after they have become brown and lifeless. This habit, while of some merit from an artistic point of view, is a very great annoyance to the lover of clean lawns and to the leaf gatherers, for the leaves of these trees fall continually from autumn until spring. The same objection is also true of some of the beeches, notably *Fagus ferruginea.*

In grouping shrubs, those with an upright habit and robust growth should either occupy a rear or central location in order that they may form the general barriers against which all lower-growing sorts may

be arranged in regular gradation to the border line, which latter should be given up to the decumbent and effeminate sorts, in order that the eye may be carried from the greensward to the top of the

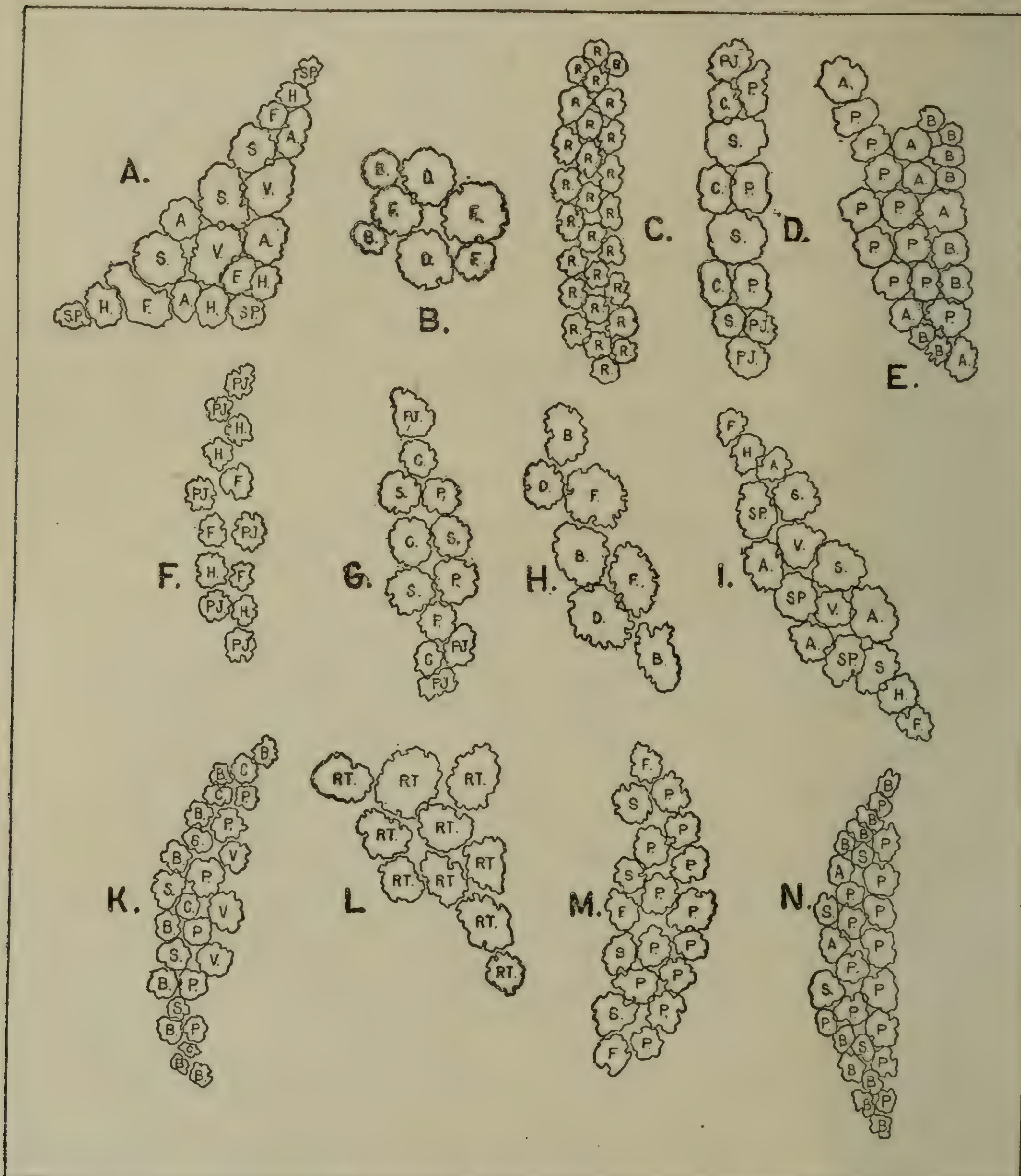

FIG. 46.—Detail of shrubbery groups shown in fig. 44: GROUP A.—F, 3 Forsythia (May); S, 3 Syringa (May); V, 2 Viburnum (June); SP, 3 Spiræa (July); A, 4 Althea (August and September); H, 4 Hydrangea (August and September). GROUP B.—D, 2 Deutzia crenata (June); F, 3 Forsythia; B, 2 Berberis. GROUP C.—R, 27 Roses in variety. GROUP D.—C, 3 Calycanthus; P, 3 Philadelphus; S, 3 Syringa (white); PJ, 3 Pyrus japonica. GROUP E.—A, 6 Althea; B, 8 Berberis; P, 10 Privet. GROUP F.—F, 3 Forsythia; H, 4 Hydrangea; PJ, 6 Pyrus japonica. GROUP G.—C, 3 Calycanthus; P, 3 Philadelphus; S, 3 Syringa (white); PJ, 3 Pyrus japonica. GROUP H.—D, 2 Deutzia crenata (June); F, 2 Forsythia; B, 3 Berberis. GROUP I.—F, 2 Forsythia (May); S, 3 Syringa (May); V, 2 Viburnum (June); SP, 3 Spiræa (July); A, 4 Althea (August and September); H, 2 Hydrangea (August and September). GROUP K.—V, 3 Viburnum plicatum; S, 4 Syringa (white and purple); C, 4 Calycanthus; B, 9 Berberis; P, 6 Privet. GROUP L.—RT, 10 Rhus typhina (sumac). GROUP M.—P, 12 Privet; S, 4 Syringa; F, 3 Forsythia. GROUP N.—P, 14 Privet; S, 4 Syringa; A, 2 Althea; B, 9 Berberis.

group without causing offense by bare stalks between the turf and the foliage of the group itself. Avoid bare trunks in evergreens and bare stalks in the group. Low-growing, dense-foliaged plants are as

FIG. 1.—EFFECTIVE SHRUBBERY PLANTATION FOR SCREENING BUILDINGS IN THE REAR.

FIG. 2.—SCREEN OF GRASSES.

essential to a successful group or border as are the tall-growing sorts. Nature herself is one of the safest guides. Her groups are always made up of a variety of light-loving and shade-enduring plants growing together, each one assisting the other to secure the environment best suited to its highest development. For instance, the ailanthus, sumac, and ampelopsis all grow and develop beautifully in full sunshine, but are, at the same time, among the most common undergrowth of the forest. Various species of Cornus, Viburnum, and Rubus adapt themselves well to under planting. It is because of these adaptations of plants to natural environments so markedly unlike that nature always presents a pleasing and restful picture.

Modern landscape horticulture is at best only a poor reproduction of the model set by nature herself, but in making the counterfeit every possible advantage should be taken of the natural adaptations of plants in order to secure the most pleasing effects from the material at command. In all planting it should be the aim to conceal the hand of the gardener to the utmost possible extent. In small formal places with straight walks and hedges, the gardener's shears must be used frequently, but the aim should always be to produce harmony and symmetry without materially altering the natural habit of the plants. Formal hedges are an exception, but specimen shrubs and trees need not be.

USE OF SHRUBS.

As has already been indicated, each group or plantation made upon the grounds should have an excuse for its existence and a reason for occupying the particular spot it does. If there are unsightly rear views, plantations in groups or belts should be provided, as shown in Pl. LXVI, fig. 1, in order to hide such objects. If a portion of the grounds is to be used for purposes other than lawn or ornamental plantations, then the purely ornamental should provide in its scheme for cutting off in a pleasing but effective way all areas used for stable or garden purposes. The bays of curved walks and drives should be filled with groups of shrubs, so that if there be no natural object for the road to make a curve around, the plantation will serve as a substitute for one, and in so doing produce one of the highest effects which can be secured in landscape gardening. By a judicious use of plants in the bays of walks and drives new and unexpected features in the form of vistas, lawn pieces, or specimen plants can be brought before the traveler, thus producing pleasant surprises and holding his interest.

MASKING OF WALKS AND DRIVES.

The planting of bays or the masking of walks and drives is one of the fine arts in landscape decoration. If care and skill are exercised, the interest of the traveler will not be allowed to flag, for at each turn in the road some new beauty will appear. The sense of discovery is an important one to be gratified. The skillful planter

realizes this and takes advantage of the curves in the road to shut out for the time being those objects of interest and beauty which lie beyond. From the nature of the result desired, tall-growing deciduous trees are not suited to this character of planting. Masking groups must be dense enough and tall enough to shut out the view. They must not be formal, but should lose their outlines gradually and grade harmoniously off into the greensward or grosser planting, according to the general character of that part of the grounds. The same rules in regard to harmony and variety hold for making groups as for those designed as shelter belts or as screens.

SPECIFIC ARRANGEMENT OF DECORATIVE PLANTS.

Returning to the groups of shrubbery provided for in fig. 44, it is desirable to combine in each group as much of interest as possible without making the group heavy and unattractive. In Group *A* it is proposed to plant the following-named shrubs in the numbers indicated: Forsythia, 3; syringa, 3; viburnum, 2; spiræa, 3; althea, 4; hydrangea, 4. The next point to settle is the relation of these plants to one another in the group. It is evident that because of the different habit and rate of growth of the several sorts mentioned their location will have an important bearing upon the ultimate character of the plantation. It is evident that the tall-growing viburnums must have a central location along with the syringas; these to be flanked by the altheas; outside of these the forsythias and spiræas, with the hydrangeas near the points of the plantation, the plantation being completed by a spiræa at each angle nearest the lawn. (For a planting plan of Group *A*, see fig. 46.) In this group there are 19 specimens representing six different types and genera of plants. The blooming season provided for in the group is, forsythia and syringa, May; viburnum, June; hydrangea and spiræa, July; althea, August and September, with the althea frequently blooming well on into October. Here, then, we have not only a variety of foliage, a different rate and habit of growth, but a blooming period beginning in May and extending well on to October, when the viburnums will begin to take on autumn coloring. In such a group each month brings a new glory in addition to the variety produced by the diversity in the shrubs themselves. Variety, harmony, and beauty are the ends sought in this plantation.

DECIDUOUS TREES.

Trees which shed their foliage at the approach of cold weather must, of necessity, form a large portion of the grosser decorative material for plantations in the North Temperate Zone. Not only do such trees make up a great portion of the indigenous growth of the region, but the deciduous trees present a great range of size and form, as well as a great variety of colors and leaf forms, features of the

utmost importance in producing variety in landscape effects. The colors which add so much beauty to the landscape during the autumn months appear only in deciduous trees and shrubs.

THE OAKS, in general, present during youth a symmetrical form, together with a variety of leaf forms and shapes which render them especially attractive objects. The broad, spreading, rugged habit characteristic of the White, Red, Rock, and Willow oaks produces a striking contrast with the numerous small-sized drooping branches and pyramidal form of the Pin Oak. The leaves of the oak range in size from the massive, broad leaves of the Mossycup Oak (*Quercus macrocarpa*), often 10 or 12 inches in length and 4 or 5 inches in width, to the short, narrow leaves of the Willow Oak (*Q. phellos*). This interesting and valuable group, both from an economic as well as æsthetic standpoint, contains not only a variety of deciduous forms, but at the South offers in the Live Oak (*Q. virginiana*), an evergreen form which is among the most valuable of the shade trees for the section to which it is adapted.

THE MAPLES.—Next to the oaks as regards variety in form and beauty of autumn coloring stand the maples. This group, like the oaks, presents dwarf, shrubby forms as well as gigantic timber trees. From the standpoint of the landscape gardener, the maples are less desirable than the oaks and many other deciduous trees, because of their liability to injury by heavy winds. The wood of this group is brittle, and the branches have an unfortunate habit of forking in such a fashion that a weak union results which, when subjected to heavy pressure from wind or ice, gives way, causing wounds which produce conditions leading to early destruction of the trees. To offset this unfortunate feature, the maples as a class are of rapid growth and symmetrical form, adapting themselves to a great variety of conditions. The Red Maple (*Acer rubrum*) is a water-loving plant, but can be quite successfully grown on the upland. The Silver Maple (*A. saccharinum*) endures under the rigorous conditions of the Northwest, and is at the same time extensively planted with satisfaction throughout the Middle Atlantic States for ornamental purposes. In autumn the most brilliant reds and yellows of our forests are produced by the maples.

AMERICAN ELM.—Among other more valuable deciduous trees, both for street and ornamental planting, may be mentioned the American Elm (*Ulmus americana*), which is hardy over a wide range, grows rapidly, and forms one of the most graceful and beautiful trees native to our forests.

THE ASHES.—The ashes are of rapid growth and have clean foliage, which gives them an attractive appearance. The one drawback to the ash as a park tree is its habit of producing great quantities of seeds, which in turn produce a crop of weedy seedlings upon the lawn.

THE LINDEN.—The American as well as the European linden are useful lawn and park trees, but do not long endure the privations of street life in cities. In the open their broad leaves, clean branches, and fragrant blossoms render them of value for lawn purposes. The extreme hardiness of the linden extends its use to the Northwest. In its native habitat it is much prized as a honey plant, and also for its timber, which is extensively used in the manufacture of light boxes and other receptacles.

THE POPLARS.—The poplars present another group of widely varying plants, which on account of their rapid growth and extreme hardiness are extensively planted in the treeless sections of the Northwest, as well as about residences in more equable climates where quick shade and protection are desired. When used for immediate effect they are usually accompanied by slower-growing trees, which when sufficiently grown will altogether replace the poplars.

WILLOWS.—Willows are seldom used either as street or park trees, but upon extensive grounds where moist situations occur which do not offer a congenial habitat for other desirable deciduous trees, the willows, because of their adaptation to such situations, are very useful.

TULIP TREE.—The Tulip tree, which is also known as the Yellow Poplar (*Liriodendron tulipifera*), is a rapid-growing tree, attaining immense size and showing most attractive, glossy, fiddle-shaped leaves. In spring, trees growing in the open show a profusion of yellow, tulip-shaped flowers, which are later followed by the characteristic fleshy fruit of the magnolia, of which it is a representative. While seldom used for street purposes in cities, it is of value for driveways and parks where trees of great size and beauty are admissible.

THE SYCAMORE.—The Sycamore or Plane tree, both native and Oriental, is a most useful street tree and as well a striking lawn or park tree. In age it presents a most picturesque appearance as a result of its sturdy, irregularly branching limbs and its peculiar greenish-white bark. The leaves of the native species suffer severely in some localities from a parasitic fungus, which detracts greatly from the value of this tree for ornamental purposes.

THE HARDY CATALPA (*Catalpa speciosa*), because of its rapid growth and symmetrical form when growing in the open, taken in connection with its broad leaves and showy racemes of flowers, has become a favorite tree for planting in the prairie regions, where comparatively few broad-leaved trees endure. Beside its ornamental value, the catalpa produces very durable timber, highly prized as post material.

HORSE CHESTNUT (*Æsculus*).—This group of trees is of especial merit because they combine with attractive form and foliage a

beautiful floral display during the months of May and June. The drawbacks to the Horse Chestnut are the objectionable litter made by the ripening fruits in the fall, and the fact that in some localities at least the European species (*A. hippocastanum*) is subject to a disease of the foliage. The hardiness of the Horse Chestnut and the beauty of its flowers and foliage are sufficient to warrant its use as a specimen tree despite its objectionable fall litter.

KENTUCKY COFFEE TREE (*Gymnocladus canadensis*).—This is a deciduous tree of an ornamental nature, with very long bipinnate leaves. It is adapted to the Middle and Western States, and produces best results in rich, moist soils. Seeds are produced in long, broad pods, the shells of which are hard and resistant when mature, as are also the seeds themselves. The growth is upright and rapid. The bark is rough, but ornamental, while the shoots themselves are stiff and blunt, the compound leaves giving the whole plant a light, airy appearance, which is augmented by their bluish-green color.

YELLOW WOOD (*Cladrastis tinctoria*).—This free-growing, ornamental deciduous tree is native to the region of Kentucky and Tennessee. It is desirable because of its rounded form, compound leaves of a bright light green, which in autumn turn to a warm yellow. Its flowers, which are generally borne in great profusion, are irregular (pea-shaped), white, sweet scented, and appear in long, drooping racemes, which frequently make the tree a veritable bouquet. It is free from disease, makes a moderate growth, has smooth bark, makes no objectionable litter in the autumn, and is therefore very desirable for lawn and city purposes.

EVERGREEN TREES AND SHRUBS.

The general effect of an evergreen or coniferous forest is that of somberness. Life is apt to have enough of the somber element forced into it by circumstances outside of one's control, and for that reason, if for no other, plantings which develop this effect in the surroundings of the home should be avoided. The use of the narrow-leaved evergreens is therefore restricted from an æsthetic standpoint. They are also generally restricted by climatic conditions to high altitudes and latitudes. A limited use of conifers at the North adds a very desirable variety to the character of a place during summer as well as during winter. In summer the effect is one of contrast in growing plants, while in winter it is, as it were, a contrast of the living with the dead. During winter the conifers by retaining their leaves carry with them an expression of life and warmth, and when draped in snow and ice the long, graceful branches of the pines and spruces present most interesting and beautiful objects. The gaunt, bare branches of the leafless oaks and maples produce a marked contrast with the compact form of a well-grown conifer.

Because of the undesirable effect resulting from the close planting

of evergreens their use is restricted. As a means of emphasizing slight elevations they are exceedingly useful. Screens which can not be made sufficiently dense or lasting with deciduous trees can well be formed with conifers. A limited use of conifers at the North is in conformity with the general character of the forest growth of the region. True, some sections show only deciduous, while others possess only coniferous, forests. In landscape gardening neither of these extremes can be followed with profit. An intermingling of evergreens with the deciduous plants produces a pleasing effect which relieves the faults of a too general use of either. At the South, however, the character of decorative plantations is of necessity very different from that at the North. Here evergreen forests abound; the marked contrast of the seasons is not emphasized in nature. Even during winter, conditions comparable with those of the spring months at the North obtain; growth is only temporarily interrupted, and there is therefore no natural reason why plants should shut themselves up in frost-proof boxes, as do the broad-leaved species of the North. At the South evergreens are the rule and not the exception. In habit of growth and character of foliage, the evergreen plants of the South, aside from the conifers, of which there are many, are quite exempt from the objection urged against the profuse use of conifers at the North. The beautiful rounded form of the Live Oak which, from Richmond, Va., southward along the coast, forms such an important feature in street and park adornment, is entirely exempt from the quality of somberness. Other broad-leaved evergreens are the magnolias, the palmettoes, the Camellia japonica, and farther South the cocoanut palm, the mango, the sapodilla, the camphor, and the citrous group. In regions with a sufficiently mild climate the Australian Pine (*Casuarina equisetifolia*) makes a most graceful avenue tree.

HARDY PERENNIAL GRASSES.

In the hardy tall-growing grasses there are valuable objects for use upon the lawn and in groups of shrubs for the purpose of adding a touch of color and variety. The coloring of such grasses as *Eulalia japonica*, varieties *zebrina*, *gracillima*, and *variegata*, is so markedly different from that of the common lawn carpet and from the shrubs used in masses and shelter belts that a pleasing contrast is afforded by interspersing them here and there. Then, too, these hardy grasses, because of their rapid growth, add a touch of variety and carry a suggestion of the tropical. Such tall-growing plants as the "tall reed" (*Arundo donax*) serve the purpose well if used in conjunction with ailanthus or sumac, which if cut back to the ground each season, will produce a marked and pleasing tropical effect. If sumac is used as the shrubbery member of the group, a most delightful touch of autumn coloring will be afforded by the rich red of its foliage during October. The best of the sumacs for this purpose is *Rhus glabra*, although the

FIG. 1.—ARTISTIC AND EFFECTIVE USE OF PERMANENT VINES.

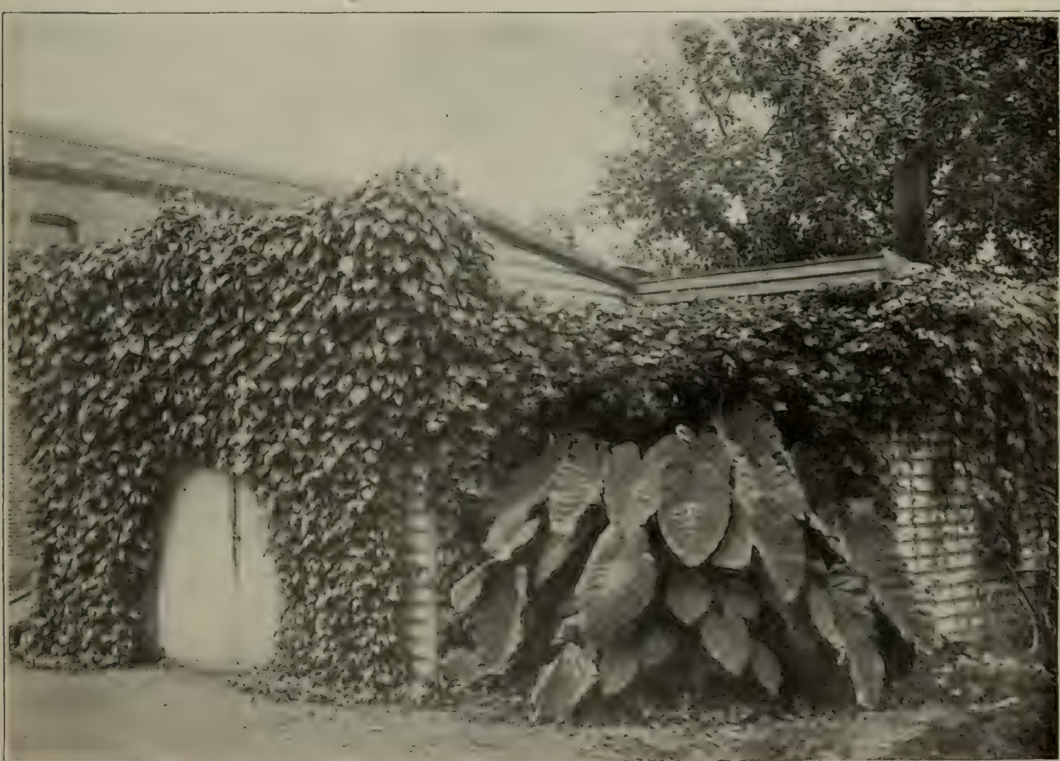

FIG. 2.—EFFECTIVE COVERING OF ANNUAL VINES.

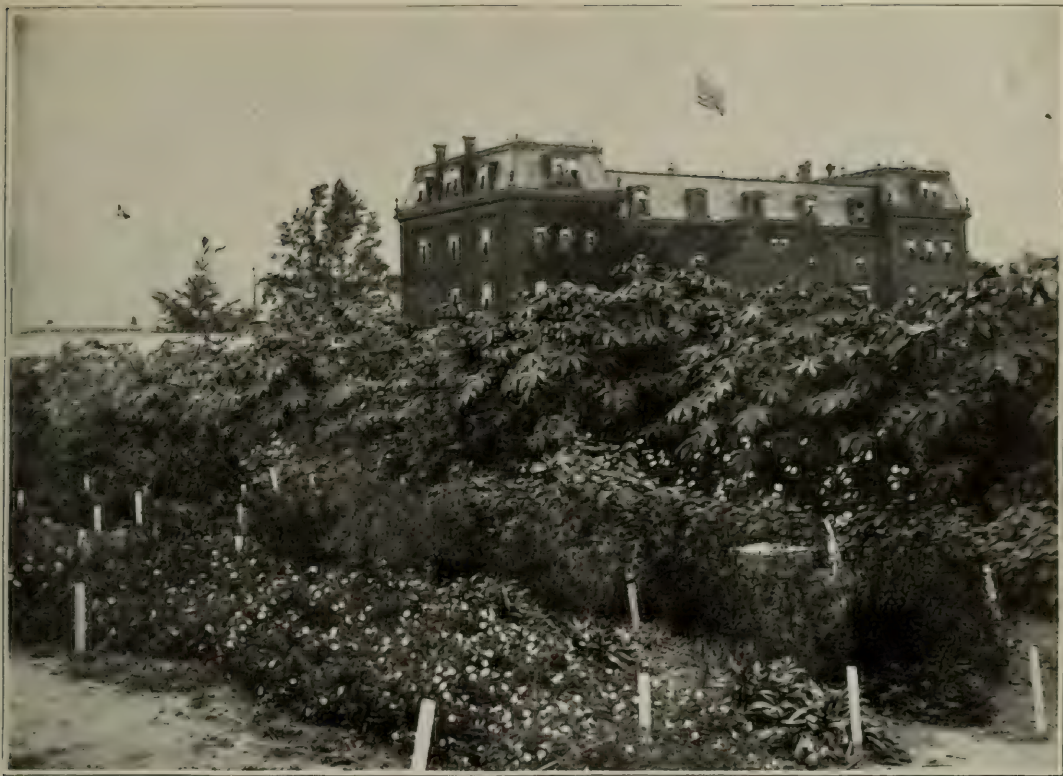

FIG. 1.—SCREEN OF CASTOR BEANS.

FIG. 2.—EMERGENCY PLANTING WITH COLEUSES, CANNAS, AND CASTOR BEANS.

hairy sumac (*Rhus typhina*) is very good, and for tropical effect the ailanthus is best of all, but it lacks the autumn charm of the other two. Besides their use as features in groups of shrubs, the grasses lend themselves well to formal plantations. When placed regularly in rows or in formal beds (Pl. LXVI, fig. 2), they become useful as well as attractive features in the planting plan.

One of the chief advantages which these plants offer is the ease and facility with which they can be increased by division, thus affording a quick and inexpensive method of securing a very satisfactory immediate effect. The hardy grasses can also be used to good purpose as the central features of herbaceous borders or beds. *Arundo donax*, as a central mass bordered by tall-growing dark-leaved cannas, which in turn are bounded by a robust coleus, such as "Golden Bedder," can be used to good advantage in a large place to produce an effect of richness and luxuriance at a minimum of cost. While such expedients can not be classed as a high or desirable type of decoration, they often serve a very useful purpose where funds are limited.

PERMANENT VINES.

Vines have a peculiar value in decorative planting in that as a class they are shade enduring; yet many of the best decorative plants of this group thrive to perfection in full sunlight. Since many vines will thrive in partial shade as well as in full sunlight, they lend themselves well to porch and arbor decoration. A few have the power to attach themselves to bare walls (Pl. LXVII, fig. 1), thus making them extremely useful in covering rough brick, stone, or wooden walls, giving them an effect of age, beauty, and appropriateness which can not be produced by artists and architectural materials. Two of the best vines for covering walls are the Boston ivy (*Ampelopsis tricuspidata*) and the English ivy (*Hedera helix*).

Vines which adjust themselves to wire or wood supports and are chiefly valuable because of their covering and shading effects are the clematis, with all its varied forms; the wistaria; the trumpet flower; the Actinidia and Akebia, both valuable cover plants. For sandy regions either as a soil binder or as an arbor or trellis cover none of the vines exceeds the Japanese honeysuckle (*Lonicera japonica*). There are many other good honeysuckles (*Lonicera*) grown for decorative purposes, but none is more rapid growing or freer from insect pests and fungous diseases than *Lonicera japonica*. In this catalogue of valuable vines two more of our native vines justly merit high places, the five-fingered ivy (*Ampelopsis quinquefolia*) and the bitter sweet (*Celastrus scandens*).

ANNUAL VINES.

Annual vines may also serve a useful purpose about a new place. (See Pl. LXVII, fig. 2.) The perennial woody vines are slow growing,

and usually make but little shade or protection during the first two or three years after planting. With annual plants, however, the case is quite different. Many annual climbing vines have a profusion of leaves, grow rapidly and luxuriantly, and afford a simple, inexpensive, yet satisfactory means of securing an immediate screen. For best results with these plants special attention to early planting, often indoors, is essential. When planting-out time arrives, place them in a rich, well-drained soil, and at all times maintain an abundant supply of moisture. Under such conditions use the moonflower (*Ipomœa grandiflora*), the *Cobœa scandens*, the morning-glory, the cypress vine (*Ipomœa quamoclit*), the hyacinth bean (*Dolichos lablab*), nasturtiums for low screens and lattices, and the wild cucumber (*Echinocystis lobata*) for taller structures.

Rustic summer houses and arbors may be very beautifully and satisfactorily adorned with Cobœa, or with wild cucumber, during the time which must elapse before the permanent vines can be grown sufficiently to cover the structure.

EMERGENCY PLANTING.

The comparative value of shrubs and perennial grasses and herbaceous annual bedding plants is at once apparent. Residents of the country or of suburban places have difficulty in securing suitable herbaceous plants in sufficient quantities to produce rich effects, and even if such plants can be secured in profusion they can not take the place of shrubs and grasses either as cover plants or as screens or wind-breaks. A complete arrangement requires a harmonious use of both shrubs and annual herbaceous plants.

For quick results, however, where shrubs of large size can not be secured or are too expensive, a temporary effect can be secured by the use of tall-growing, broad-leaved plants, such as the castor bean (*Ricinus*), the canna, and the caladium. The castor bean grows rapidly, is easily propagated from seed, comes true to variety, affording in one plant a wide range of color in foliage and stature. This plant frequently grows 6 to 8 feet in height from seed, even as far north as New York, in a single season. Its broad-spreading habit, together with its attractive foliage, which in well-nourished plants is retained well down to the ground, renders the castor bean a very satisfactory makeshift or substitute for shrubbery where screens and masking masses are needed (Pl. LXVIII, fig. 1). The trouble with all such makeshifts is that their effect lasts a few months only, while with shrubs the benefit is lasting and they serve quite as useful a purpose in the way of shelter belts and screens in winter as during the summer. For sake of variety, the caladium and canna can be used to good advantage in connection with the castor bean (Pl. LXVIII, fig. 2). The tall habit of the canna and the broad leaves of the caladium render them well fitted for massing. Such plants as the castor bean, the

canna, and the caladium can be used to good purpose in shrub borders and masking groups before the shrubs are sufficiently grown to produce the effect desired. Even after the shrubs have grown sufficiently to accomplish the end sought an occasional mass of castor beans, asters, eulalias, or arundo interspersed at intervals will lend variety and life to the groups.

CULTURAL SUGGESTIONS.

In addition to a well-executed general planting plan the successful development of a place depends on the knowledge of first principles, the preparation and fertilization of the soil, the pruning and planting of trees and shrubs, and the making and maintenance of a greensward.

PREPARATION AND FERTILIZATION OF THE SOIL.

The nature of the plantations upon a city lot or suburban place is such that the main part of the cultivation must necessarily be done before the plantations are made. The soil should be thoroughly pulverized, brought to a general grade, and the surface fined and raked with a steel-tooth rake. If a lawn is to be made at this time, the grass seed should be sown immediately after the raking, after which the surface should be thoroughly compacted by the use of a heavy lawn roller. Fertilizers for the lawn should be free from weed seed and be of a lasting nature. If the soil is heavy it can be improved by plowing in a crop of cowpeas or Canada field peas. If this can not be done, the next best plan is to use thoroughly composted or sterilized stable manure. If the soil is naturally light its store of plant food can be augmented with bone meal. This should not be plowed under, but harrowed in at the time of fining and compacting the soil.

PRUNING AND PLANTING TREES AND SHRUBS.

The critical period in the life of a plant is when it is transplanted from the nursery to its permanent location. In moving trees from the nursery a portion of the root area is lost, and the top should be reduced in proportion to the loss of root area, in order that the newly transplanted and unestablished plant may be able to secure sufficient moisture and food to supply the demands of the top. The roots should also be pruned, so as to protect them against decay, by cutting away all broken and mutilated parts, leaving the cut surfaces smooth and in such position that they will come in contact with the fresh earth. After the plant becomes established certain branches will grow more rapidly than others and the appearance of the plant will be spoiled by this unequal growth. Pruning should, therefore, be resorted to in order to preserve a symmetrical development of the plant without rendering it artificial or formal in appearance. Care should also be exercised during the early development of a plant to maintain a uniform distribution of branches around the central axis, if it be a tree, so as to

insure a symmetrical and pleasing tree at maturity. At planting time the excavation prepared for the reception of the tree should be deep enough to allow it to be set at the same depth it stood in the nursery and large enough to accommodate the roots without bending them, while the earth in the bottom of the hole should be loosened at least one spade length below the general floor of the hole. In replacing the soil over the roots of the plant a thin layer of earth should be placed immediately in contact with the roots and thoroughly firmed by trampling in order to bring the particles of soil in close contact with the feeding roots of the plant. The hole should then be filled and the surface left slightly above the general surface of the surrounding ground.

MAINTENANCE OF A GREENSWARD.

Newly established lawns should never be allowed to mature seed. Frequent clipping with the lawn mower, if not made too close, tends to stimulate the stooling of the plants rather than to interfere with their growth. If the lawn is located in a dry portion of the country or portions subject to long periods without rain, it will be necessary to irrigate or sprinkle. A little water is an injury rather than a benefit. If watering is begun it should be done at night rather than during the day, and sufficient water given to thoroughly wet the soil. During the winter the new lawn should have a dressing of coarse litter or, if the soil is poor, of thoroughly composted stable manure. If neither of these is available or desirable, a fall dressing of bone meal will be found very useful. In the spring, as growth begins, the lawn should be raked with a steel-tooth rake, any breaks carefully filled in with turf or seeded, and the whole area rolled with a heavy roller. Subsequent treatment will consist in maintaining the moisture by proper use of water and frequent clipping with the lawn mower.

CONCLUSION.

To harmoniously arrange trees, shrubs, and herbaceous plants, and at the same time adjust them to the contour of the place, to the architecture of the buildings, and to the convenience of the walks and drives, is the aim of the landscape gardener. As his guide and model, he takes nature, and in so far as this is accomplished his work is pleasing. Every successful attempt to adorn a city lot, a suburban place, or a park has a valuable influence upon the community in which it is situated. It furnishes an object lesson which others will attempt to follow, and in this way it serves the useful purpose of stimulating in others a love for the beautiful in nature. Fortunately, the beauty which is produced by ornamental plantings can not be selfishly kept for the exclusive use of its owner; every passer-by can take the full measure of his capacity without in the least detracting from the value of the plantation to its owner. Every person who plants a tree is a public benefactor.

PRACTICES IN CROP ROTATION.

By George K. Holmes,
Of the Division of Statistics.

COURSES PURSUED IN THE PAST.

Since the early days of agriculture in every part of this country farmers first robbed the soil of its fertility and then resorted to various devices to get a paying crop. A favorite device was to run away from the problem and seek new land; another, to give the land a complete rest from production. In the meantime live stock increased, and barn manure, at first a farm nuisance, was more and more applied to the land, manures were composted, commercial fertilizers were employed, and sod was plowed under every few years. A true conception of the benefit, almost necessity, of rotating crops gained a foothold under the stress of hard conditions, and this expanded into farm practice, even to the extent of raising manuring crops for the sake of plowing them into the soil.

The poverty of the soil and the want of a "money crop," before neighboring urban populations became important, and while farming communities were isolated for want of railroads and navigable rivers, early forced the New England farmers into a varied agriculture and dairying, and the long, inclement winter confined the live stock in yard, shed, and stable. New England is a region of high production per acre.

In proceeding westward from the East, the rule is, the longer the occupation the more developed the crop rotation. A diminution in the degree of rotation hardly appears until Ohio is passed, and then the diminution is gradual until in the longitude of middle Kansas rotation is of the simplest, when existing at all. Agriculture in a great portion of the North Central States began with one-crop or two-crop production.

The one-crop cotton planters in the South followed the new land westward until they could find no more; then they let the land rest, and afterwards used commercial fertilizer for many years, and they have only just begun to enter a phase of simple and effective crop rotation without much aid from live stock.

In the rainy part of the Pacific Northwest the history of crop rotation is about the same as that of the middle and western parts of the North Central States. Little history has yet been made in this matter

by the arid and semiarid regions; aside from the growing of alfalfa agriculture remains as it began, except that there is a gradual diminution of soil fertility, even under irrigation, where alfalfa is not grown.

GENERAL VIEW OF THE PRESENT.

The present paper has been prepared from reports made by thousands of correspondents of the Department of Agriculture, representing every agricultural county in the United States; the statements regarding customs and farm practices, including crop rotations, in the different sections of the country are summaries of these reports.

Little systematic rotation of crops is found in this country. One-crop farming is still practiced in some parts, as corn on bottom land or cotton in the South, corn or wheat in the North Central States[a] and the Southwest, and wheat on the Pacific coast. The constant cropping of the "corn bottoms" of the South and of the North Central States is sustained to some extent by the annual deposit from freshets. The cotton land receives commercial fertilizer, and much of it is rested every few years, but is in a low condition of fertility. The continuity of wheat or corn in the North Central and Pacific States is broken by complete rest in many counties, and the soil is becoming less productive. Rest for the soil is not a common practice in the North Central States; the extension of crop rotation is preventing this.

Haphazard is a mild word to describe the impression given by the reports of correspondents with regard to the rotation of crops in many counties and parts of counties of the United States. Although there may be an annual change of crop on the same land, this change is so uncertain, so unsystematic, that at first it seems impossible to establish order out of the chaotic mass of particulars. Some fundamentals may be discerned, however, in a broadly general sense.

Throughout the region north of the cotton belt there is a three-crop rotation which may be regarded as a system with innumerable variations. These crops are corn, small grain (wheat, oats, barley, rye), and grass or legumes; and the period covered by the rotation in some of its variations is commonly four or five years and not infrequently extends to eight or ten or more years, the length of the period depending mostly upon the ability of the grass or legumes to remain productive. Sooner or later most of the tillable land that is not bottom land or is not devoted to one crop, fruit or vegetables, passes through this rotation, but often with interruptions or the admixture of other crops in the effort to adapt the products to markets, prices, soil, weather, and the special or general objects of farming.

In some regions which produce considerable tobacco, potatoes, or beans, a portion of the land that would otherwise be given to corn may be given to one of these crops in this general rotation.

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[a] This group of States includes the following: Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska, Kansas.

This fundamental rotation north of the cotton belt will better be understood by noticing the variations presented in the list of leading rotations contained in this paper.

In the cotton belt, as far as any systematic rotation of crops is discoverable, it is cotton and corn, but this is subject to the repetition of cotton because of larger area than corn, to the resting of the soil for a year, to the inclusion of cowpeas, and of various small crops of sorghum, oats, sweet potatoes, etc., in the course of several years, during which the primary rotation may have occurred two or three times. Variations of the primary cotton rotation will be observed in the subsequent list of leading rotations.

In the arid and semiarid regions, which comprise that part of the country lying west of the one hundredth meridian, except a border on the Pacific Ocean, the crop rotation, outside of vegetable and fruit production, tends to maintain the growth of alfalfa as long as possible. In the reseeding year wheat or other small grain is sown. There is, however, considerable resting of land throughout this entire region as a poor substitute for renewing the fertility of the land by the use of alfalfa, for alfalfa is not grown where grain is the chief product. In western Oregon and Washington, where the rainfall permits the introduction of grasses, the rotation chiefly includes only small grains and grasses, and in some counties only the small grains.

For California, it is impossible to arrive at a fundamental crop rotation on account of radical differences in soil, water supply, and climate. The reports received show the practices to be almost as numerous as the counties, and indeed some counties have several practices in different parts. With regard to wheat and barley the general practice is that the land rests every second or third year, in which it produces nothing but weeds and wild oats. Some Pacific coast rotations are given in the list of leading rotations.

THE MORE GENERAL ROTATIONS IN WHICH SPECIFIED CROPS ARE GROWN.

In connection with the following rotations a few prominent counties are mentioned for illustration, and not because the rotations are confined to them. The States are leading or prominent ones in their geographical divisions. Grass, alfalfa, or the clovers, at the end of a rotation, generally continue as long as they are sufficiently productive.

CORN.

PENNSYLVANIA.—Corn, small grain two years, grass two years (Bucks, Berks, Chester, York, etc.).

ILLINOIS.—Corn indefinitely (Vermilion). Corn two years, small grain, grass (Champaign). Corn, oats, corn, oats, clover (Livingston, Peoria).

CALIFORNIA.—Corn, wheat, oats (Napa).

GEORGIA.—Corn, oats, cotton (Thomas, Laurens). Corn, cotton two years (Burke). Cowpeas are frequent in either case, but are grown in the same year with either corn or oats.

TENNESSEE.—Corn, wheat, clover (Gibson, Obion, Giles). Corn two years, wheat, clover (Weakley). Corn with cowpeas, wheat (Lawrence).

WHEAT.

PENNSYLVANIA.—Corn, wheat two years, grass two years (York, Franklin, etc.). Corn, oats, wheat, grass three years (Chester, Westmoreland).

MINNESOTA.—Wheat two years, oats, wheat, flax (Marshall). Corn, wheat two years, oats (Lac qui Parle). Corn, wheat two years, grass two years (Ottertail, Todd, etc.).

WASHINGTON.—Wheat, rest (Adams).

CALIFORNIA.—Wheat, rest (Solano, San Joaquin, etc.).

MARYLAND.—Corn, wheat two years, grass two years (Montgomery, Frederick, Talbot, etc.). The rotation on dairy and stock farms includes wheat for only one year.

OKLAHOMA.—Wheat without rotation (Grant, Garfield, Kingfisher, etc.). Wheat, corn (Dewey). Wheat three years, oats (Kay).

OATS.

NEW YORK.—Oats two years, hay three years (Jefferson). Corn, oats, rye, hay two years (Ontario). Corn, oats, hay two years (Steuben).

IOWA.—Corn, oats, hay two years (Butler, Floyd, Kossuth, etc.). Corn, oats two years (Cerro Gordo). Corn two years, oats, hay two years (Franklin).

OREGON.—Wheat, oats, corn or rest (Marion). Wheat, oats two years, grass (Linn).

SOUTH CAROLINA.—Corn, oats, cotton (Darlington, Edgefield, Sumter). Corn, oats, grass (Marion, Saluda).

OKLAHOMA.—Oats, corn (Oklahoma).

BARLEY.

NEW YORK.—Corn or potatoes, barley, wheat, grass two years (Orleans, Seneca). Corn, barley, grass two years (Steuben).

MINNESOTA.—Barley two years, clover two years (Wabasha). Barley, corn, oats, corn, wheat (Rock).

CALIFORNIA.—Barley, rest (San Luis Obispo, Monterey, etc.).

RYE.

MASSACHUSETTS.—Corn, rye, grass two years (Franklin). Corn, oats, rye, grass two years (Hampden).

New Jersey.—Corn, rye, grass (Morris). Corn, potatoes, rye, hay, grass (Monmouth).

Michigan.—Corn, rye two years, clover two years (Allegan). Corn, rye, clover (Gratiot).

Kentucky.—Corn, rye, clover two years (Clark). Tobacco, rye, clover (Grant).

Rye occupies the same place as wheat in usual rotations, but is adapted to lighter soils.

BUCKWHEAT.

Pennsylvania.—Buckwheat, oats, rye, grass two years (Bradford, Wyoming). Buckwheat, oats, grass three years (Tioga).

West Virginia.—Buckwheat, wheat, grass two years (Marshall, Hampshire, etc.). Buckwheat, corn, wheat (Tucker). Buckwheat up to six years without change (Preston).

Wisconsin.—Buckwheat, rye, grass two years (Juneau). Potatoes two years, buckwheat, rye, corn (Juneau). Corn and rye in two-year rotation, occasionally with buckwheat (Adams).

POTATOES.

Maine.—Potatoes, oats or barley, grass several years (Kennebec, Lincoln).

New York.—Potatoes, small grain, grass two years (Steuben, Seneca). Corn, potatoes, oats, rye, clover (Ontario).

Wisconsin.—Potatoes, grain two years, grass two years (Columbia, Portage, Waupaca). Potatoes, corn, potatoes, grass two years (Waushara). Potatoes, wheat, clover two years (Adams).

Colorado.—Alfalfa, potatoes, wheat, potatoes, wheat (Larimer). Peas, potatoes, wheat, rest (Conejos).

Virginia.—Potatoes two crops in one year, sweet potatoes two years, corn (Accomac). Potatoes and corn the same year, oats plowed in and cowpeas the second year (Northampton).

Kentucky.—Potatoes planted on sod, preferably clover (Kenton).

HAY.

New York.—Corn, small grain, hay three years (St. Lawrence, Delaware). Corn, oats, wheat, hay two years (Chautauqua).

Iowa.—Corn two years, oats, hay two years or more (Dubuque, Ringgold, Johnson, Fayette, and many other counties).

California.—Largely native grasses mowed indefinitely (Siskiyou, Modoc, Orange, Contra Costa). Alfalfa five years (Los Angeles).

Virginia.—Corn, wheat, hay three years (Shenandoah, Loudoun). Corn, wheat two years, hay two years (Rockingham, Warren, Page, Frederick, Augusta). Corn, oats, wheat, hay two to nine years (Tazewell, Wythe).

Kentucky.—Corn, small grain, hay two years (Bourbon, Jefferson).

COTTON.

In all cotton States the crop is grown to a large extent indefinitely on the same land without rotation, but with a year of rest now and then. Cowpeas are often sown in standing cotton or in the corn which alternates with cotton or are grown after small grain in the same year. The following rotations also are more or less practiced:

NORTH CAROLINA.—Cotton, corn, peanuts, or small grain with cowpeas (Edgecombe, Johnson). Corn, cotton two years, small grain (Robeson). Corn, cotton (Sampson).

SOUTH CAROLINA.—Cotton, corn, small grain with cowpeas (Laurens). Cotton three years, corn with cowpeas (Orangeburg).

GEORGIA.—Cotton two years, corn with cowpeas (Burke). Cotton three years, small grain, corn, small grain with cowpeas (Baldwin).

FLORIDA.—Cotton, corn with peanuts (Madison). Corn, cotton, corn, cotton, oats (Jackson).

TENNESSEE.—Cotton three years, corn (Shelby). Cotton two years, corn with cowpeas (Madison). Cotton repeated until the land is abandoned (Fayette).

ALABAMA.—Cotton three years, oats with cowpeas (Wilcox). Cotton two years, corn with cowpeas (Covington). Cotton, corn with cowpeas, small grain (Pike).

MISSISSIPPI.—Cotton, corn (Yazoo). Cotton, corn with cowpeas (Holmes).

LOUISIANA.—Cotton, corn (Iberia). Cotton two years, corn with cowpeas (Grant, Natchitoches).

OKLAHOMA.—Cotton without rotation (Payne, Lincoln, Pottawatomie, Greer, etc.).

ARKANSAS.—Corn, cotton, oats with cowpeas (Lee, Jefferson, etc.). Cotton continuous on bottom lands.

TOBACCO.

CONNECTICUT.—Tobacco without rotation (Hartford). Corn (rye sown), (rye plowed under) tobacco, grass (Litchfield). Tobacco two years, corn, tobacco, clover (Tolland).

PENNSYLVANIA.—Tobacco, oats, wheat, hay (Clinton). Tobacco without rotation (Tioga, Bradford).

OHIO.—Tobacco, wheat, grass two years (Montgomery, Brown, and quite general).

WISCONSIN.—Corn, tobacco three years (Jefferson, Rock). Tobacco without rotation (Crawford, Vernon, Columbia).

VIRGINIA.—Tobacco, wheat, clover two years (Pittsylvania, Halifax, Charlotte, Lunenburg, Bedford, Brunswick, Nottoway, Cumberland, etc.). Tobacco, wheat (Halifax). Bright tobacco, rest (Mecklenburg). New land grows two to five crops of tobacco, then wheat.

NORTH CAROLINA.—Tobacco, wheat, corn (Stokes, Nash). Corn, tobacco, hay, or rest (Pitt).

KENTUCKY.—Tobacco, wheat, clover (Graves, Caldwell, Webster). Corn, tobacco, wheat, clover two years (Christian). On new land, corn, tobacco, wheat (Graves, Logan).

FLAX.

NORTH DAKOTA.—Wheat, flax, oats, barley, rest (Benson). Flax three years, small grain (Ramsey). Corn, flax, wheat, oats (Cass). Flax three years in five (Wells). Wheat two years, flax, wheat, oats (Grand Forks). Flax comparatively new in Ramsey and Wells.

SUGAR CANE.

LOUISIANA.—Cane two years, corn (Avoyelles). Cane three years, corn with cowpeas (Plaquemines).

RICE.

GEORGIA.—Rice, potatoes, corn (Camden).

LOUISIANA.—Rice without rotation (Plaquemines). Rice three years, other crops one year to clear the land of red rice (Iberia, Calcasieu).

PEANUTS.

VIRGINIA.—Corn, peanuts (Nansemond, Sussex, Surry, Isle of Wight). Crimson clover with peanuts, cotton (Southampton). Peanuts, corn, vegetables (Nansemond). The great bulk of the crop is produced with corn in two-year rotation, cowpeas or crimson clover often being sown in the corn.

NORTH CAROLINA.—Corn, peanuts (Hertford, Bertie). Corn with cowpeas, peanuts, cotton two years (Bertie). Corn, peanuts, oats with cowpeas, peanuts (Northampton).

KAFIR CORN.

KANSAS.—Kafir, rye, corn, millet (Rooks). Kafir, corn (Osborne, Russell). Kafir, corn, sorghum (Geary). Kafir after wheat in the same year, as a catch crop (Dickinson). Rotations not systematic; kafir is largely a catch crop.

OKLAHOMA.—Kafir without change (Woods). Corn, kafir, sorghum (Greer). Wheat and kafir in the same year without other rotation (Oklahoma).

DAIRY AND LIVE-STOCK FARMS.

[*d*, dairy; *l s*, live stock.]

NEW YORK.—(*d*) Ensilage corn, oats with peas, grass three years (Delaware). (*l s*) Hay and pasture nearly permanent (Steuben).

IOWA.—(*d*) Corn, oats, grass three years (Kossuth, Winneshiek). (*l s*) Corn, oats, clover (Greene).

NEBRASKA.—(*d*) Corn, millet, sorghum, oats, alfalfa permanent (Valley); corn, wheat, clover two years (Colfax). (*l s*) Corn, wheat, with permanent wild grass for hay and pasturage (Buffalo); corn two years, oats, corn, oats (Burt, Thurston).

CALIFORNIA.—(*d*) Ensilage corn, oats for hay (Sonoma); small grain two years, grass two to six years (Humboldt). (*l s*) Natural grass exclusively (Santa Clara); natural grass pasture, alfalfa hay—no rotation (Kings).

VIRGINIA.—(*d*) Corn, soiling crop, small grain, hay, pasturage (Loudoun, Fairfax). (*l s*) Corn, small grain, grass three years (Fauquier, Shenandoah, Wythe, Carroll, etc.).

KENTUCKY.—(*d*) Corn, wheat or oats, grass three years (Campbell, Kenton, Shelby).

TENNESSEE.—(*l s*) Oats, grass indefinitely (Davidson); corn with cowpeas, oats, grass two years (Knox).

MULTIPLE CROPPING.

Multiple cropping was reported by correspondents to an extent that permits a wide survey of the field. For the guidance of correspondents multiple cropping was defined to be "two or more crops usually harvested from the same field in the same year; pasturage is a crop, even if after hay or grain in the same year, and every cutting of grass is a crop." Pasturage, as a second or third crop, is prevalent; two or more cuttings of grass or legumes are common, especially where alfalfa is grown, nine cuttings of this forage plant, making 14 tons of hay per acre, being the largest number reported for irrigated land. A double crop of small grain and clover is numerously reported. Aside from the regions producing alfalfa, triple cropping is more generally found in Florida than elsewhere.

A high degree of multiple cropping in rotation is reached in the hothouse production of vegetables, where the soil never rests; the limit is generally four crops a year in rotation.

The development of multiple cropping has been carried further in China than in any other country. Chan Laisun, in an address in Massachusetts in 1873, gave the following as an example of soil utilization by Chinese farmers and gardeners: "The plains of the southern and middle provinces are made to yield two or three crops in rotation every year; at the north only two. But when patches are laid out for raising vegetables, five, six, seven, and even eight crops are realized."

PRACTICES IN SELECTED STATES.

NEW ENGLAND AND NEW YORK.—Hay twice; hay and pasture; small grain and pasture (little); early potatoes or garden peas and turnips or cabbage; to some extent late vegetables follow early ones. Corn and beans, pumpkins, or turnips, occupy land together. *Maine* reports two crops of potatoes; early hay and Hungarian grass. *New*

Hampshire—early hay and field-pea hay or turnips; green rye and peas or oats. *Vermont*—early hay and fodder corn, beans, green barley, or cabbage. *Massachusetts*—early hay and millet, barley, or winter squash; oat hay and barley; green rye and corn, oats, or millet. *Rhode Island*—barley and potatoes; rye and clover; 2 crops of hay and pasturage. *Connecticut*—corn and rape; 3 crops of clover; hay and fodder corn; green rye and silo corn. *New York*—hay and buckwheat; clover, 2 crops and seed; potatoes and beans or winter squash.

ILLINOIS.—All grain and grass fields pastured after harvest. Wheat and corn, clover hay, pasturage, clover seed, millet (followed by pasturage), Hungarian hay, peas, or beans. Rye and millet (followed by pasturage) or cowpeas. Winter rye pastured until June, followed by millet. Oats and hay, clover, or cowpeas. Timothy hay and corn or pasturage. Strawberries and corn. Potatoes and millet, turnips, or corn. Clover hay and seed, sometimes followed by pasturage. Clover hay and millet, cowpeas, or beans. Corn and rape or turnips.

WISCONSIN AND MINNESOTA.—Alfalfa, 3 crops; hay, 2 crops; hay and pasturage; clover hay and seed. Double plowing confined to small areas, largely for soiling crops, as rye hay and fodder corn, pasturage and turnips, oat hay and millet, corn and rape. Early cut small grain and rape, millet, buckwheat, or turnips. Early clover hay and potatoes, turnips, fodder corn, millet, or buckwheat.

IOWA.—Substantially the same double croppings as prevail in Wisconsin and Minnesota. The pasturing of hay and grain stubble is general and plowing of winter grain stubble for fodder corn, millet, or rape is rather more frequent. Potatoes and turnips or cabbage. Alfalfa to 4 cuttings. Corn and pumpkins, rape, or rye; the latter two, for fall pasturage, grow together.

NEBRASKA.—Winter grain and pasturage, rape, turnips, or buckwheat. Potatoes and millet, rape, or rye. It is common to pasture wheat and rye all winter and then secure a crop of grain. Hay, 2 cuttings, or 1 cutting and pasturage; alfalfa to 5 cuttings; 2 crops of millet, oat hay, and sorghum hay. Rape or rye grows in corn for fall pasture. No double cropping in the semiarid region.

IDAHO AND WYOMING.—Double cropping mostly dependent upon irrigation. Potatoes and turnips. Wheat and alfalfa hay. Small grain and hay, followed by pasturage. Two crops of oat hay, rye hay, potatoes, red clover, and timothy; alfalfa, 3 crops and pasturage.

WASHINGTON.—Two cuttings of clover, mixed hay, or alfalfa. Hay or small grain and pasturage. Peas and oats, potatoes and turnips, turnips and cabbage. No double cropping in eastern Washington, except with irrigation.

CALIFORNIA.—In rainy districts hay or grain and corn, oats, clover, rape, or buckwheat. Strawberries and hay; vetches and corn

or turnips; clover and potatoes; clover hay, seed, and pasturage. Two or more cuttings of hay; 8 months' pasturage and hay. Irrigated alfalfa to 9 cuttings; clover and tame grasses, 2 or 3 cuttings. In southern California, small grain and corn, potatoes, beans, pumpkins, turnips, Egyptian corn, or celery. Two crops of peas, potatoes, rye, oat hay, and summer and winter vegetables. No double cropping without irrigation in dry regions, except pasturage on hay and small grain stubble.

South Carolina and Georgia.—Small grains (especially oats) or potatoes and corn, cotton, cowpeas, sweet potatoes, millet, peanuts, sorghum hay, potatoes, or watermelons. Potatoes and cabbage, turnips, or other truck crop. All cultivated crops and crab-grass hay or pasture. Corn and cowpeas, turnips, or beans grow together on the same land, and 3 crops are obtained by growing any of these combinations after oats or wheat.

Florida.—Small grain stubbles produce all the crops noted for Georgia, and double cropping is much more general. "A crop of hay grows after all early cultivated crops;" "two or more crops on nearly all land." Three crops are raised in the following combinations: Cabbage, beans, and hay; melons, sweet potatoes, and turnips; potatoes, melons, and peas; 2 crops of hay and cabbage; cabbage, beans, and hay. Peculiar to this region are rice after vegetables, beggarweed hay after corn or cotton, or 2 crops of beggarweed hay. Tobacco is followed by Irish or sweet potatoes, peas, turnips, etc.

Kentucky.—Corn and stubble pasture, cowpeas, rape, sorghum, or beans. Wheat and millet, Hungarian grass, crab grass, rape, turnips, corn, sorghum, buckwheat rarely, or cowpeas with clover or with crab grass. Oats and hay, cowpeas, millet, or clover. Rye and millet, soy beans, clover, or cowpeas with rape. Clover hay and seed; bluegrass seed and pasture; millet and corn; clover and sorghum or sweet corn with cowpeas; timothy, redtop, and clover with cowpeas; hay and cane for fodder; cowpeas growing with corn. Potatoes and sweet corn, beans, corn, or turnips. Onions and potatoes with cabbage. Two crops of hay, cowpeas, sorghum, and vegetables; alfalfa 3 to 4 cuttings (little grown). All grain and hay fields are pastured.

Louisiana.—Corn with cowpeas and crab-grass hay or pasturage. Oats and hay, cowpeas, sweet potatoes, pasturage, millet, cotton, or June corn with cowpeas. Wheat and millet, potatoes, or sometimes corn. Potatoes and cotton, turnips, or corn with cowpeas. Two crops—hay, prairie grass, Bermuda grass, and potatoes.

CROPPING IN ORCHARDS.

In orchards there is some secondary cropping. During orchard growth, before fruit bearing, crops are raised in great variety, but after an orchard is five or six years old grass is generally the additional crop. Correspondents report the following crops in the earlier

years: Cotton, sorghum, sugar cane, corn, fodder corn, sweet corn, kafir corn, oats, wheat, rye, rape, tobacco, peas, cowpeas, berries, vetches, barley, buckwheat, beans, velvet beans, flax, castor beans, potatoes, sweet potatoes, turnips, and various vegetables.

The grasses and legumes found mostly in the older orchards are timothy, orchard grass, red clover, alfalfa, Hungarian grass, millet, crimson clover, scarlet clover, bluegrass, crab grass, sedge grass, wild grass.

It is a growing belief among farmers that orchards should not be cropped and that the grass in them should remain.

From some States it is reported that orchards are used as poultry yards, or swine, calf, and sheep pastures. In young orange groves in Florida all crops are raised, but little if anything after the trees begin to bear. In several States, especially in the South, the orchards are neglected and weeds are the chief growth between the trees. Some of the best fruit men in Missouri cut the grass and let it remain on the ground. In the dry orchards of Idaho the ground needs to be cultivated to hold moisture. While various practices may be found in California, the general rule is to avoid cropping orchard land, even when the trees are young; the ground is left entirely free from weeds and grass by constant cultivation with plow or harrow. In young walnut orchards corn is sometimes grown for a few years.

USE OF FERTILIZERS.

Correspondents reported fully concerning the use of fertilizers as an incident in crop rotation. There are still extensive regions in the United States where barn manure is considered a farm nuisance. In a county of Oregon the neighbor is welcome to haul away this manure, and that neighbor is likely to be a thrifty German with a large garden; in other Oregon counties the manure is burned. In a California county the manure is dumped into ravines; it goes to the creek in Oklahoma; it is hauled to a hole in the ground or put on one side of the field in Kansas; South Dakota farmers burn it to be rid of it, and sometimes burn it for fuel. In North Dakota farmers haul barn manure to piles and leave it there until it disappears; farmers in Missouri deposit it by the roadside, and in Idaho scrapers are used, and it is "often seen piled as high as a barn."

In many counties between the Mississippi River and the Pacific Ocean farmers not only find barn manure a nuisance, but they have a grievance against it, claiming in South Dakota that it produces dog fennel, elsewhere that it produces other weeds, and in various counties that it has such an effect of "poisoning" the soil that farmers are afraid of it. The owner of a large California wheat ranch required a tenant last year to spread the barn manure of the ranch upon the wheat land, but the tenant, after doing so, set fire to the stubble and burned the manure.

In semiarid regions barn manure needs to be used cautiously on unirrigated land; in the wheat lands of California it is more or less visible for four or five years after its application to the land. The practice of two hundred years ago survives in some parts of the South; cattle are penned upon the land to increase its fertility, and the pen is shifted as the owner desires.

In a large portion of the North Central States barn manure is removed to prevent accumulation and deposited upon the fields throughout the winter, to be plowed under in the spring. In the East it is allowed to accumulate until spring, when it is deposited upon the land just before plowing. The use of this fertilizer for top dressing grass land is very common throughout the principal portion of the United States wherever it is used in considerable quantities.

Barn manure is more generally applied to corn than to any other crop, although a liberal application of it is made to tobacco, potatoes, and vegetables. Commercial fertilizer is liberally used in cotton production, in the more intensive agriculture of fruit and vegetable raising, and in growing small grains, to which it is applied with a seeder at time of seeding. The use of barn manure is greatest in the East, while commercial fertilizers have the greatest use in the cotton belt. The use of any kind of barn or commercial fertilizer is more and more sporadic westward from Indiana, and commercial fertilizer is hardly anywhere seen west of the Mississippi River except on vegetable and fruit farms. The Southern farmers are not sufficiently supplied with live stock, especially that which is stabled, to have much barn manure, and their chief reliance to supply fertility to the soil is upon commercial fertilizer and cowpeas. Farmers plow under green manuring crops, especially alfalfa and other legumes, in all parts of the United States, and the farmers who do not do so are still relying upon what they regard as an inexhaustible fertility of soil, or are cultivating a partly worn-out soil without understanding the cause of their hard conditions.

EFFECTS OF TENANCY.

Farm tenancy is a distinct damage to crop rotation, particularly in the South. This is not entirely due to one-year tenancies, but is partly due to the character or poverty, or both, of the tenant; to the indifference and, also, in a degree, to the poverty of the landlord. These conditions are more especially found in the cotton belt, which often presents the worst situation for crop rotation. Given absentee landlords residing in town and paying little attention to their plantations, living very likely on credit until their cotton can be grown and sold; given tenants who do not know how to rotate crops without constant supervision, and who, like the landlord, are living on the future crop; and still further, given merchants who advance supplies and demand that the security shall be made ample to pay the prospective debt by the production of cotton, which is a ready cash crop—given

all of these conditions, and it can hardly be expected that the rotation of crops will make any progress. Yet, this is the situation throughout a considerable portion of the cotton belt. Hence, the dependence for fertility upon rest from production and upon commercial fertilizers; hence, washed-out and gullied fields, and only one-third of a bale of cotton to the acre.

In the East tenancy has a less effect upon rotation than in other parts of the country, because the landlords more commonly require the customary practice of a change of crops, but the landlords of the North Central States are less careful to protect their farms. The best tenants are found in the North Central States and Pacific Northwest. A Wisconsin correspondent writes that some tenants are well educated and follow a rotation better than the owners. West of the one hundredth meridian tenancy seems to make little difference with rotation. A general observation, gathered from the reports, for the whole country is that while tenancy is bad for rotation, its practices are generally only a degree worse than those of the owners in the same region who cultivate their own farms. As is the landlord, so is the tenant, only worse.

ATTITUDE OF THE FARMERS.

Why do not farmers more generally rotate their crops? The answers of correspondents are varied, and may be thus condensed:

(1) New land; (2) old land still regarded as inexhaustible; (3) reliance upon commercial fertilizer for land without humus; (4) the credit system in the South; (5) the poverty of the farmer, preventing an advancement of soil enrichers; (6) tenancy, with the features of short term, absent landlord, credit, poverty, indifference, and incapable tenant; (7) special inducement to raise one money crop, as corn near distilleries in Kentucky and Ohio, hay near lumber camps in Michigan; (8) the limitations of the semiarid region; (9) contempt for "book farming," and preference for grandfather's "rule o' thumb;" (10) keeping a small number of live stock; (11) when the soil is sick with overcropping, the farmer is not well enough informed to know the nature and cause of the malady; (12) the farmer is in a rut, lacks initiative, and needs help to get out; (13) the cash and cotton rents are so high that the tenant can not get a start in rotation.

Among obstacles to rotation of another sort, which make it more or less incomplete, are drought, insects, fungous diseases, a hard freeze at the wrong time, a bad winter, failure of clover or grass seed to grow, and a change in market demand from one crop to another. Then again in extensive agriculture the small farm is at a disadvantage in rotating crops as compared with the medium or large farm.

The reports of correspondents indicate that there is nearly everywhere in the regions where crop rotation is little practiced at least a fraction of farmers who know the consequences of single cropping, or

what substantially amounts to that. They report worn out pastures, land with its chemical elements not well proportioned and deficient in humus, land uncovered by sod for many years, with its fertility washed into the creek, and with its surface "so gullied that a coon couldn't cross it." They report cockleburs, moss, wild grass, and weeds, with such a foothold that they can not be eradicated without rotation of crops; the ground infested with noxious worms and insects.

To avoid such waste, progressive farmers rotate crops; and there are other motives—the distribution of farm work throughout a longer period, the retention of moisture in the soil, and, as reported from Kansas, four crops for as many years from one plowing, namely, corn, wheat, grass, and grass.

Notwithstanding many a gloomy neighborhood view presented by correspondents, crop rotation is steadily extending and progressing. The South has made remarkable advance within a few years, owing to the cowpea. Among the many thousands of reports of correspondents one great fact stands out prominently, and that is the influence of the experiment stations and farmers' institutes. These are mentioned in almost every State, and with gratitude with the exception of one State, where general agriculture is at a low ebb and the farmers are inert.

The expansion of dairying appears in every direction; it is pushing into the Northwest and taking the place of wheat and other small grains; it has developed rapidly in the humid and semihumid districts of the Pacific coast; it is making a perceptible advance throughout the South; and the dense population of the East is stimulating its growth faster than in any other division of States except the Rocky Mountain and Pacific.

The country never before saw such demand, and such growing demand, for leguminous seeds for sowing—the clovers, alfalfa, the vetches, peas and cowpeas, and soy beans and velvet beans. Numerous reports state that the farmers have just been awakened as from a long sleep, and that they are feeling their way with rotations in which a part is generally taken by a legume, and the awakening is often referred to as beginning at a farmers' institute.

The impression derived from the many reports is that crop rotation is progressing faster in many parts of the South and in western Oregon than elsewhere; and that next in order is that region in the North Central States that lies between the old and the new, but within this region Missouri appears to be making the least progress. Unirrigated lands in the arid and semiarid regions labor under such limitations that they can not be compared with other parts of the country in such a matter as crop rotation. As hopeless as farming operations seem to be in some regions in rotating crops, a general view of the whole country can not help but give one a hopeful impression, because progress preponderates and has never before been so rapid.

TESTS ON THE PHYSICAL PROPERTIES OF TIMBER.

By F. E. Olmsted,
Assistant Forester, Bureau of Forestry.

OUTLINE OF TIMBER-TESTING WORK IN EUROPE.

From the beginning of the eighteenth to the middle of the present century investigations of the strength of wood received more or less attention, principally from French scientists. Owing to the limited scale upon which the work was done and to the rather crude methods employed, the results were necessarily contradictory and unsatisfactory. In 1848 Chevandier and Wertheim published the results of tests they had made on timber of the Vosges Mountains. This was the first case in which a fairly good history and description of the test material was given, and their results are even now in use.

Most of the modern work in timber testing is founded on that of Dr. H. Nördlinger, chief forester at Hohenheim, Wurttemberg. The results of his investigations were published in 1860. Among the most important tests of recent years are those made by Bauschinger and published at Munich in 1883 and 1887. These tests were made on Scotch Pine and Spruce from the Black Forest, and special attention was given to the conditions under which the timber grew. The main object of the work was to determine the influence of forest conditions and the time of felling on the strength of the wood. In the publication of 1883 the following statements are made, modified by the clause that they should be taken as a near approach to the truth only:

(1) Stems of spruce or pine which are of the same age at equal diameters, and in which the rate of growth is about equal, have the same mechanical properties (when reduced to the same moisture contents), irrespective of local conditions of growth.

(2) Stems of spruce or pine which are felled in winter have, when tested two or three months after the felling, about 25 per cent greater strength than those felled in summer, other conditions being the same.

Bauschinger, in his publication of 1887, further modifies these statements and admits that a great many more tests must be made in order to prove their truth. He agrees in general with Hartig, however, that good conditions of growth produce a good quality of wood.

OUTLINE OF TIMBER-TESTING WORK IN THE UNITED STATES.

In America the most extensive work in timber testing has been done by the Division of Forestry of this Department, and by Mr. T. P. Sharples, in connection with the Tenth Census.

TESTS IN THE TENTH CENSUS.

The tests made for the Tenth Census were very comprehensive, and included work on 412 species; they were not intended, however, to be of practical applicability as accurate data for the strength of the various species. As Mr. Sharples says, "The results obtained are highly suggestive; they must not, however, be considered conclusive, but rather valuable as indicating what lines of research should be followed in a more thorough study of this subject."

TESTS BY THE DEPARTMENT OF AGRICULTURE.

The timber tests made by the Division of Forestry of this Department were begun in 1891 and interrupted in an incomplete state in 1896. The laboratory work was carried on under the supervision of Prof. J. B. Johnson, at St. Louis, and the material was collected from the forest itself with special reference to the conditions under which it was grown. The results, therefore, are of value not only as giving data for the strength value of various woods, but also as indicating the effect of different conditions of locality on the quality of the timber. The tests include 32 species, with 308 trees, furnishing 6,000 test pieces and material for over 45,000 tests; 20,000 pieces were used for physical examination, to determine structure, character of growth, specific gravity, moisture conditions, and other properties. The principal part of the work was done on Southern pines—Longleaf, Cuban, Shortleaf, and Loblolly. Tests were also made on the following species: White Pine, Red Pine, Spruce Pine, Bald Cypress, White Cedar, Douglas Spruce, White Oak, Overcup Oak, Post Oak, Cow Oak, Red Oak, Texan Oak, Yellow Oak, Water Oak, Willow Oak, Spanish Oak, Shagbark Hickory, Mockernut Hickory, Water Hickory, Bitternut Hickory, Nutmeg Hickory, Pecan Hickory, Pignut Hickory, White Elm, Cedar Elm, White Ash, Green Ash, and Sweet Gum. Of these, the greatest number of tests were made on Bald Cypress, White Oak, Cow Oak, Overcup Oak, and Spanish Oak.

Dr. B. E. Fernow, under whose direction the tests were made, makes the following statement in regard to the work:

> As will be observed, some species, like the Southern pines, have been more fully investigated, and the results on these (published in Circular 12, Division of Forestry) may be taken as authoritative. With those species of which only a small number of trees have been tested this can be claimed only within limits and in proportion to the number of tests.

Data are given in Circular No. 15, Division of Forestry, for all these species in the following kinds of tests: Compression endwise, bending

at rupture, bending at relative elastic limit, compression across the grain, and shearing with the grain. The results obtained are in all cases reduced to 12 per cent moisture contents. This was assumed to be the "highest average moisture contents of seasoned wood."

Among other special tests the following were made:

(1) Effect of "bleeding" on Longleaf Pine. The results indicated that the strength was not affected.

(2) Influence of size of the beams on strength. The results indicated that large beams "may be as strong as the small sticks cut from them."

(3) Influence of size in compression members. The results indicated "that columns may be as strong as small compression pieces, and when weaker the presence of internal defects probably accounts for the difference."

(4) To ascertain the effect of hot-air treatment in dry kilns. "The results indicate no detrimental effect, contrary to common opinion."

TESTS AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

Prof. G. Lanza, at the Massachusetts Institute of Technology, has done a considerable amount of timber-test work, and in 1894 published his results in Applied Mechanics. Tests were made on a limited number of Yellow Pine and White Oak columns and spruce pillars and compression tests on White Pine and Yellow Pine posts. Transverse tests to determine the breaking load, modulus of rupture, and modulus of elasticity were made on beams of the following species: Yellow Pine, 52 beams; White Oak, 36; White Pine, 37; Hemlock, 17.

In addition, a series of "time tests" were made on spruce and Yellow Pine; the weights were allowed to remain on the beams for periods of from one month to over a year. From these time tests Professor Lanza draws the conclusion that "the deflection of a timber beam under a long-continued application of the load may be two or more times that assumed when the load was first applied." Professor Lanza is strongly in favor of using sticks of merchantable sizes for testing material as against small pieces. In regard to tests on small pieces he says:

> While a great deal of interesting information may be derived from such tests as to some of the properties of the timber tested, nevertheless such specimens do not furnish us with results which it is safe to use in practical cases where full-size pieces are used. Inasmuch as these small pieces are necessarily much more perfect (otherwise they would not be considered fit for testing), having less defects, such as knots, shakes, etc., than the full-size pieces, they have also a far greater homogeneity. They also season much more quickly and uniformly than full-size pieces. In making this statement, I am only urging the importance of adopting in the experimental work the same principle that the physicist recognizes in all his work, viz, that he must not apply the results to cases where the conditions are essentially different from those he has tested.

MISCELLANEOUS INVESTIGATIONS.

In addition to the investigations mentioned above, timber tests have been made on a small scale in various parts of the country, but owing to lack of system and omission of important details they have but little practical value. Tests on the Southern pines are in a more complete state than those of other species, but it may be stated as a whole that there are to-day no reliable data at hand on the strength of the principal merchantable timbers of the United States. In other words, there are no figures on the strength and durability of American woods which an engineer feels fully justified in applying to his practical work.

TIMBER-TESTING WORK PROPOSED BY THE DEPARTMENT OF AGRICULTURE.

From the foregoing, it is evident that there is an urgent need for reliable data on the strength of American timbers; it is also plain that such data should be obtained according to an exhaustive and systematic plan. Although in many instances wood is being replaced by metal, the former will always hold an important place as a material for constructive and other purposes, and as the supply of timber diminishes, as it is rapidly doing, it becomes more and more necessary to determine its true value, so that it may be used to the greatest economic advantage. There is evidence to show that many of the species which are now classed as "inferior" may with safety take the place of timbers in common favor at the present time. No accurate data whatsoever exist as to the strength of timbers of the Pacific slope; and as these are becoming more and more important and will form the great source of supply in the future, it is desirable that their strength and durability be accurately determined at the present time.

THE INVESTIGATIONS PLANNED.

The Bureau of Forestry of the Department intends to resume the work of timber testing and to conduct the tests on a large scale, in order that the work may eventually include all the principal species of the country. The aim is to obtain results of the greatest practical value to engineers and others directly interested in the utilization of timber. The work will be divided into several series, as follows:

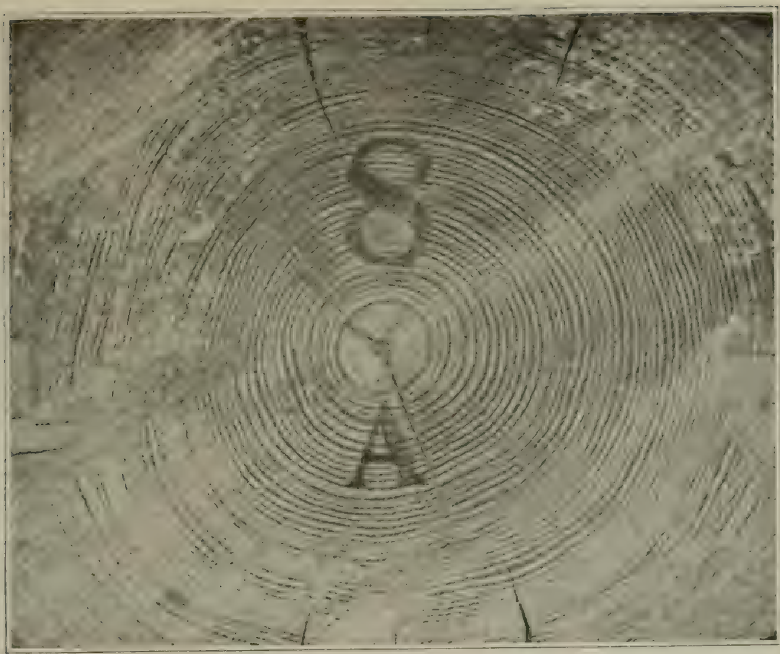
Series I: Tests on timber collected from the open market.

Series II: Tests on timber collected from the forest.

Series III: Tests to determine the effect of moisture and volatile oils on the strength of timber.

Series IV: Tests to determine the effect of preservatives on the strength and durability of timber.

Series V: Tests to determine the effect of kiln-drying methods.



END SECTIONS OF BEAMS FROM LONGLEAF PINE, PHOTOGRAPHED BEFORE TESTING.

BEAMS FROM LONGLEAF PINE.

[No. 1, Large timbers, photographed before testing, 10 by 12 inches by 16 feet; No. 2, break in a large beam after cross-bending test; No. 3, lines of rupture in small beams after cross-bending test.]

Series VI: Tests to determine the effect of the time rate of application of load on the mechanical properties of timber, including impact tests.

This is an exhaustive programme and can be carried out only after many years of work; the results obtained, however, will be fully worth the time and labor.

Results of practical value are expected in the immediate future from Series I, and these tests will be undertaken for the purpose of furnishing reliable data within a short time on the most important species now in common use. Specimens for testing will be purchased in the open market without special regard to the conditions under which the trees grew, and the locality from which they came will be mentioned in a general way only, as "from Berkeley County, S. C.," or "from Lewis County, Wash." It is often impossible to determine the botanical species from an examination of the manufactured timber; in many cases several distinct botanical species are sold under one market name. In this series of tests, therefore, the names of species will be given only so far as practicable, and only those distinctions will be drawn which can be made by the engineer or inspector in practice.

In the tests of Series II, "on timber collected from the forest," there will be no difficulty, of course, in determining the species. The work in connection with these tests will be more difficult and occupy more time than that of the former tests, and will not begin until the Bureau of Forestry is in a position to undertake the work in a thorough manner. This will be an investigation of the greatest importance, and especially of great practical value to the owners of timber lands. A tree is a living thing, and therefore wood, even of the same species, has a much greater variation in strength than iron or other metals. The strength of iron or steel depends upon the manner in which it is manufactured, whereas the strength of wood depends largely upon the conditions under which it grew. By noting such facts as the density of the stand, the nature of the forest mixture, the position of the tree in the forest, and the character of the locality and soil, a relation will be obtained between the strength of the timber and the conditions of growth. The physical properties of the wood also differ according to position in the tree, and this must also be considered. Such an investigation will therefore be of great service to practical forestry, for it will show under what conditions the best quality of timber is produced.

"The effect of moisture and volatile oils on the strength of timber," Series III, is one which will require careful study. It has been found in former tests that timber when moist may be 50 per cent weaker than when comparatively dry. All test material must therefore be reduced to a common degree of moisture contents, and in the case of many species the volatile oils must also be taken into account. For this purpose a method is under consideration which reduces the disks (to

be tested for moisture contents) to shavings. These shavings are placed in an iron retort surrounded by a steam jacket, and through them is passed a current of steam which carries off the volatile oil to a condenser, where it is separated from the water and weighed. To determine the total volatile matter, shavings from the same disk are dried in vacuo until the water is driven off, a stream of dry air being passed through to carry off the volatile matter. From the total volatile matter thus obtained the volatile oils as determined by the first process are deducted, the remainder being the moisture.

Methods of treating wood with various preservatives with a view to prolonging its life are now in common use and are becoming of greater importance every day. But little is yet known as to the effect which such treatment has upon the strength of the timber, and therefore the tests in Series IV will be of particular interest. There is also much difference of opinion about the effect of kiln-drying, and this matter will receive careful attention in Series V.

In Series VI static tests will be made at different time rates of application of loads on large timbers, and both static and impact tests will be made on small selected sticks, of the material and size, for instance, used in carriage manufacture.

In all the tests made according to this general plan special emphasis is to be laid upon the description of the material. There is a wide variation in the quality of timber of any one species, and therefore investigations which do not consider the defects of each stick tested have but little value. All the large beams are photographed on the four sides and both ends, and after testing, a view is taken of the break. (See Pls. LXIX and LXX.) In addition to this a written description of each stick is also made, and the imperfections, amount of sapwood, and rate of growth are noted.

The tests are made at several stations in different parts of the country, and all the work is done according to a uniform plan arranged by the Washington laboratory.

IMPROVEMENT OF CORN BY SEED SELECTION.

By C. P. Hartley,

Assistant in Physiology, Plant-Breeding Laboratory, Bureau of Plant Industry.

INTRODUCTION.

Anyone who has made comparative tests of varieties of corn has noticed the great difference both in amount of corn produced and in the forms of the stalks, ears, and kernels of the several varieties. While it is not definitely known from what source corn originated, it is believed that many, and perhaps all, of the existing types have a common origin. These different types have resulted from seed selection or hybridization, which in some cases has been natural, caused by the survival of the fittest or by isolation, and in other cases has been produced by man either intentionally or accidentally. These existing differences among the many varieties of corn, together with their continuous variability, are sufficient proof of the possibility of producing varieties much superior to those now in existence. On every farm changes are taking place in the characters of the corn grown, which may be either beneficial or detrimental. In order that the grower may take advantage of such variations, discarding the detrimental and increasing and rendering more stable the beneficial, it is necessary that the method of growth of the corn plant and the laws of heredity be understood.

If the benefits of careful seed selection should be questioned, it is but necessary to show that the best and most productive varieties of corn now existing are those that have been selected with the most care for a series of years. Whenever corn of this kind is planted in a location to which it is adapted in comparison with varieties of that neighborhood that have had no attention paid to their improvement, the well-selected corn shows its superiority. In many instances the harvest is doubled without extra labor or cost, save the use of good rather than indifferent or poor seed.

POSSIBILITIES OF INCREASE IN YIELD AND IMPROVEMENT IN QUALITY OF CORN.

In some of the great corn-growing sections of the United States little or no attention is paid to the quality of the seed planted. This is largely due to the fact that soil and climatic conditions are so favorable to the growth of corn that what is considered a good crop is obtained notwithstanding the poor quality of the seed planted. In

other sections not so well adapted to corn growing more pains are taken regarding the seed planted and methods of cultivation, and the result is that more corn is harvested per acre than in the sections naturally adapted to corn growing. Thus, for the ten years from 1892 to 1902 the general average yield of corn per acre in the New England States was 36.48 bushels, while in the leading corn-producing States—Ohio, Indiana, Illinois, Iowa, Nebraska, Kansas, and Missouri—the average was but 27.78 bushels, or almost 9 bushels less per acre. For the same ten years the average production of the States of New York, Michigan, Wisconsin, Minnesota, South Dakota, and North Dakota was 27.6 bushels per acre, and of New Jersey, Pennsylvania, Delaware, Maryland, West Virginia, and Virginia 26.97 bushels per acre, while the States of South Carolina, Georgia, Alabama, Mississippi, Louisiana, and Texas averaged but 13.59 bushels per acre.

The average production of corn in the United States from 1892 to 1902 was 23.51 bushels per acre, which is less than one-third of what it might and should be if proper methods of seed selection and cultivation were practiced. Good farmers frequently raise from 75 to 100 bushels of corn per acre. The secret of a good yield consists in causing each stalk in the field to produce a good ear. This should be the case if every stalk grew from a well-developed kernel from a good seed ear and had its requisite amount of space in the row. Good-sized ears of the commonly cultivated varieties of corn will weigh about a pound a piece. When the stalks stand 18 inches apart in rows 3½ feet wide, there are 8,297 stalks to the acre, and if each of these stalks produces an ear weighing 1 pound, the yield will be 122 bushels of ear corn per acre, estimating 68 pounds per bushel.

Just as there is the possibility of a very great increase in the quantity of corn produced per acre, so there is the possibility of a very great improvement in the quality. It is hoped that in the near future the quality of the corn will govern its price more than is the case at present. It is as unfair to have one price for all grades of corn as it would be for a creamery to pay one price for milk without regard to its quality. Grain buyers realize that one lot of ear corn is sometimes worth much more than another, because it gives more shelled corn per bushel, but as yet they seldom pay any more for the better corn. The same price is paid to all, on the theory that where one man's corn falls short in shelling, that of another will overrun sufficiently to bring up the average. A carload of 800 bushels of ear corn like the ear shown in Pl. LXXI, fig. 1, would yield but 728 bushels of shelled corn, while a similar carload like the ear shown in Pl. LXXI, fig. 2, would yield 893 bushels.

The nutritive value of corn is also a line along which there is much room for improvement. The same is true of the flavor, sweetness, and richness of table corn. A hardy and productive corn having

the good table qualities of some that are deficient in hardiness or productiveness would be heartily welcomed by canners, as well as by consumers in general.

CORN A WIND-POLLINATED PLANT.

The two important facts that must be kept in mind by one striving to produce a valuable variety of corn are, first, that selecting and continued planting of corn having certain desirable characters will gradually increase the characters and render them more stable; and, second, that every seed kernel has within it the latent characters of two parent plants, the mother plant, upon which the kernel grew, and the father plant, from which the pollen came that fertilized the kernel. Some give attention only to the plant upon which a seed ear grows and lose sight of the fact that the characters of the plant from which the wind brought the yellow dust-like pollen exert as great an influence in determining the characters of the corn that will grow from the seed as do the characters of the plant upon which the ear grew. One can make some progress toward the improvement of a corn by giving attention only to the seed ears and the plants upon which they grow, but the progress will not be as rapid as it may be made by also giving attention to the pollen parent. Furthermore, a corn can never be made to attain any satisfactory degree of fixedness or uniformity if planted within wind-pollinating distance of other types of corn. Studies of xenia[a] and the planting of corns of different colors in adjacent fields have shown that wind readily carries corn pollen several hundred feet, and that a quarter of a mile is a safe distance to separate varieties to prevent a troublesome cross pollination. Many growers express surprise that ears of so many forms and colors are found in their corn, although they always select for seed, ears of their favorite type. The explanation is that cross pollination with other types of corn has taken place. Perhaps a neighbor grows another kind of corn in an adjacent field, or the grower's own truck patch of sweet corn and popcorn may be at the end of the cornfield, and the wind carries the pollen of these various corns to the silks of the field corn from which he selects seed. As surely as the pollen from the popcorn or sweet corn has fertilized the silks of any of the ears afterwards selected as seed ears, so surely will some of their characters appear in the next crop, and the grower wonders whence come ears of so many types when he knows he planted seed from ears of no such types. A few simple experiments, which can be performed in a short time by any corn grower, would produce results that would vividly impress upon his mind the indispensable value of the pollen the wind shakes from the corn tassels and the various effects produced by cross pollination. If a shoot of sweet corn be covered with paper

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[a] Bulletin No. 22, Vegetable Physiological and Pathological Investigations, U. S. Dept. Agr., 1900.

or muslin before any silks appear, so that the silks are never allowed to become exposed to pollination, no kernels whatever will be formed. If, however, some pollen from the tassels of a field corn be placed upon the silks of a similarly inclosed shoot of sweet corn it will be found when the ear ripens that the kernels produced much resemble the field corn, being quite different from kernels of other ears on the same stalk.

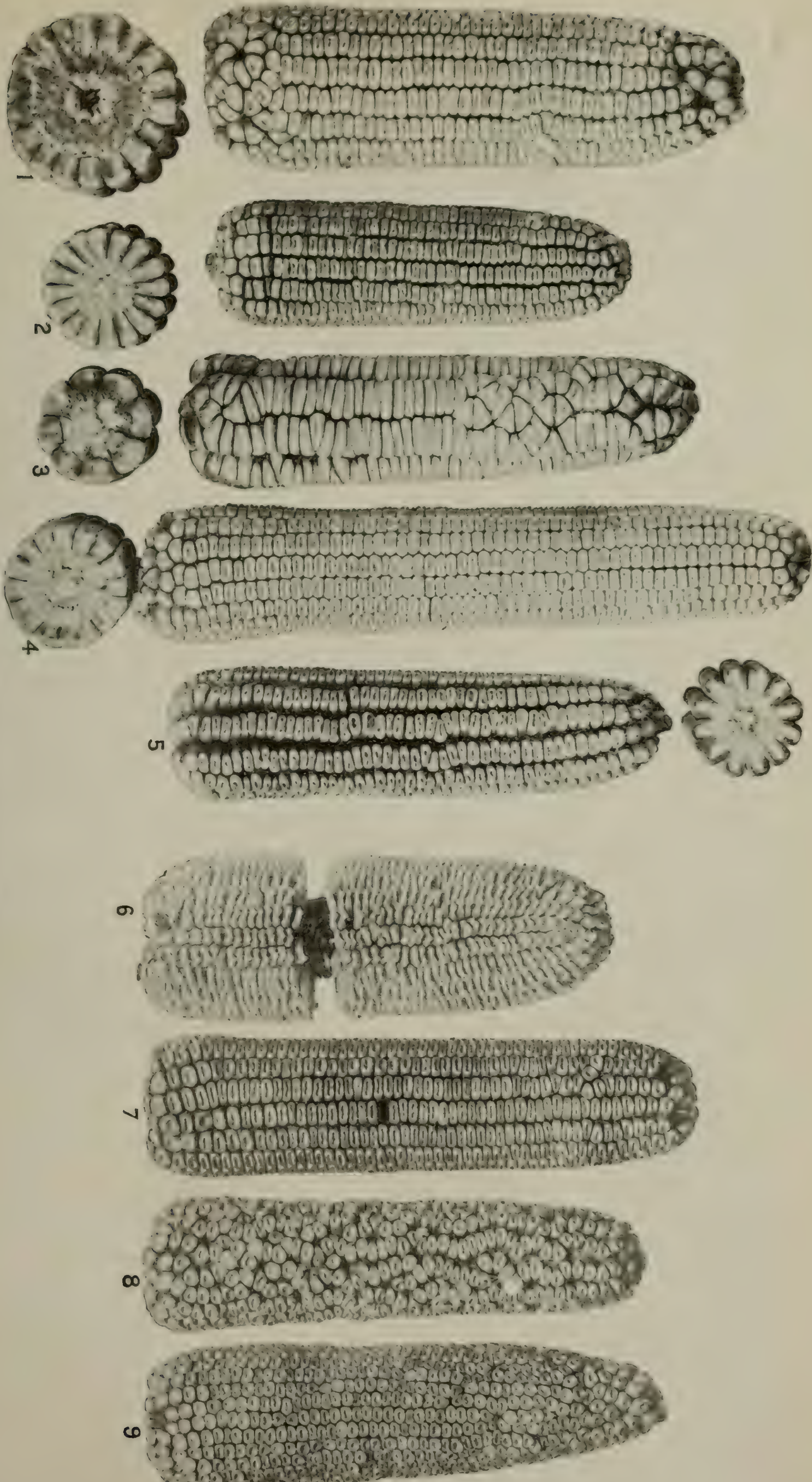
IMPORTANCE OF STALK, EAR, AND KERNEL IN SELECTING SEED.

In order to show the necessity of giving attention to the characters of stalk, ear, and kernel in selecting seed, six experiments will be briefly described. The first two experiments show that seed ears transmit the characters of the parent stalks.

In the summer of 1900 a stalk of the variety known as Pedrick's Perfected Golden Beauty was noticed to have exceptionally broad leaves. A shoot on the stalk was inclosed in a paper bag, and when the shoot grew into full silk the silks were pollinated with pollen from the same stalk. Seed from the resulting ear was planted in 1901 and the plants produced were very noticeable during the summer because of their very broad leaves. Many of the leaves were 6 inches broad and sufficiently extraordinary to attract the attention of all who passed by the row. Pl. LXXII, fig. 2, shows the first stalk in the row and the broad blades can be compared with the blades of an ordinary stalk like that shown in fig. 1 of Pl. LXXII. Seed from this row planted in 1902 produced plants which exhibited the same character.

In 1901 in a field of tall-growing white dent corn a few short and very leafy stalks were noticed. Three of these stalks are shown in Pl. LXXIII, fig. 1. These stalks were but from 4 to 5 feet tall and bore from 18 to 20 broad blades, while the normal stalks of the same corn were 10 feet tall but bore fewer blades. The tassels and shoots of these leafy plants were bagged, as shown in the illustration, and at the proper time were cross pollinated by hand one with another. The resulting seed was planted in 1902 in one row of a field planted with seed from the normal tall stalks of the same corn. How very much this row resembles the parent stalks is shown in Pl. LXXIII, fig. 2. The difference in the appearance of the stalks in this row from those seen in the rows on either side is the result of one year's seed selection with reference to the characters of the parent stalks.

The following experiment illustrates the power of seed ears to transmit their own characters even when the characters of the pollen plant are left out of consideration. The object of the experiment was to verify the usually accepted truth that "like begets like" by showing that ears possessing a low percentage of shelled corn, that is, having a small amount of corn in proportion to the weight of cob, would produce a crop low in percentage of shelled corn, while seed ears high in percentage of shelled corn would produce a crop correspondingly high



EARS OF CORN OF DIFFERENT TYPES.

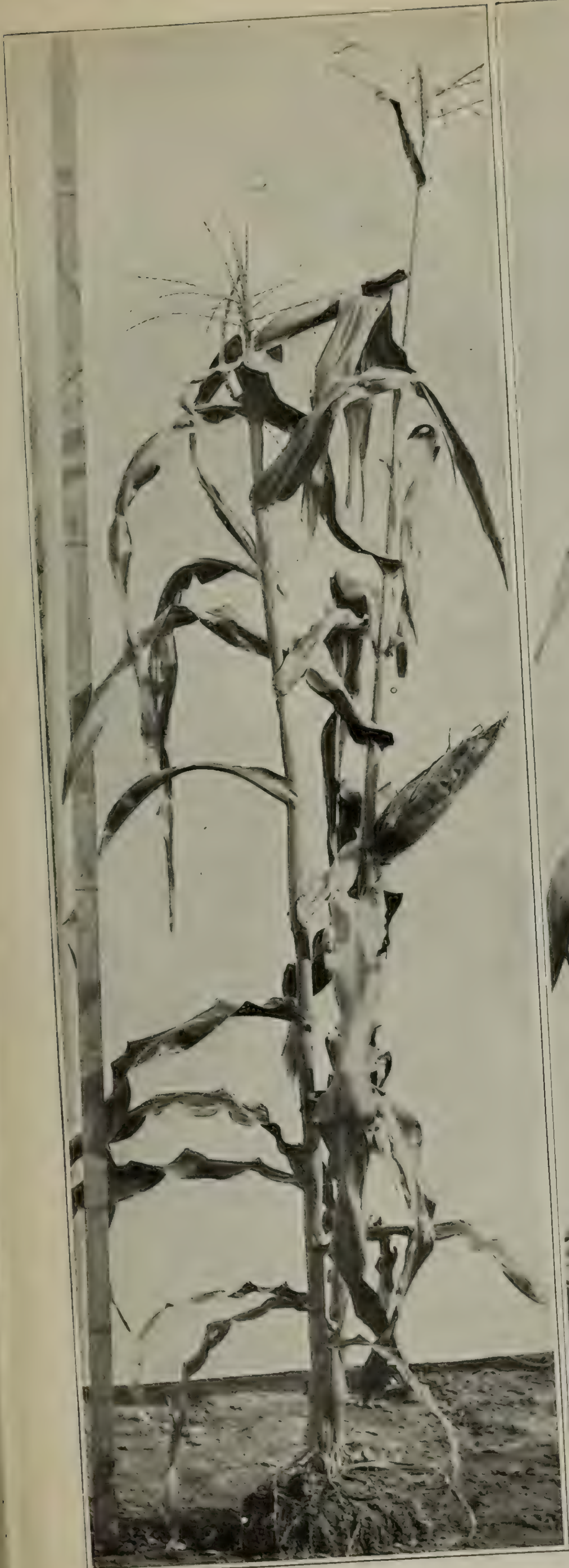
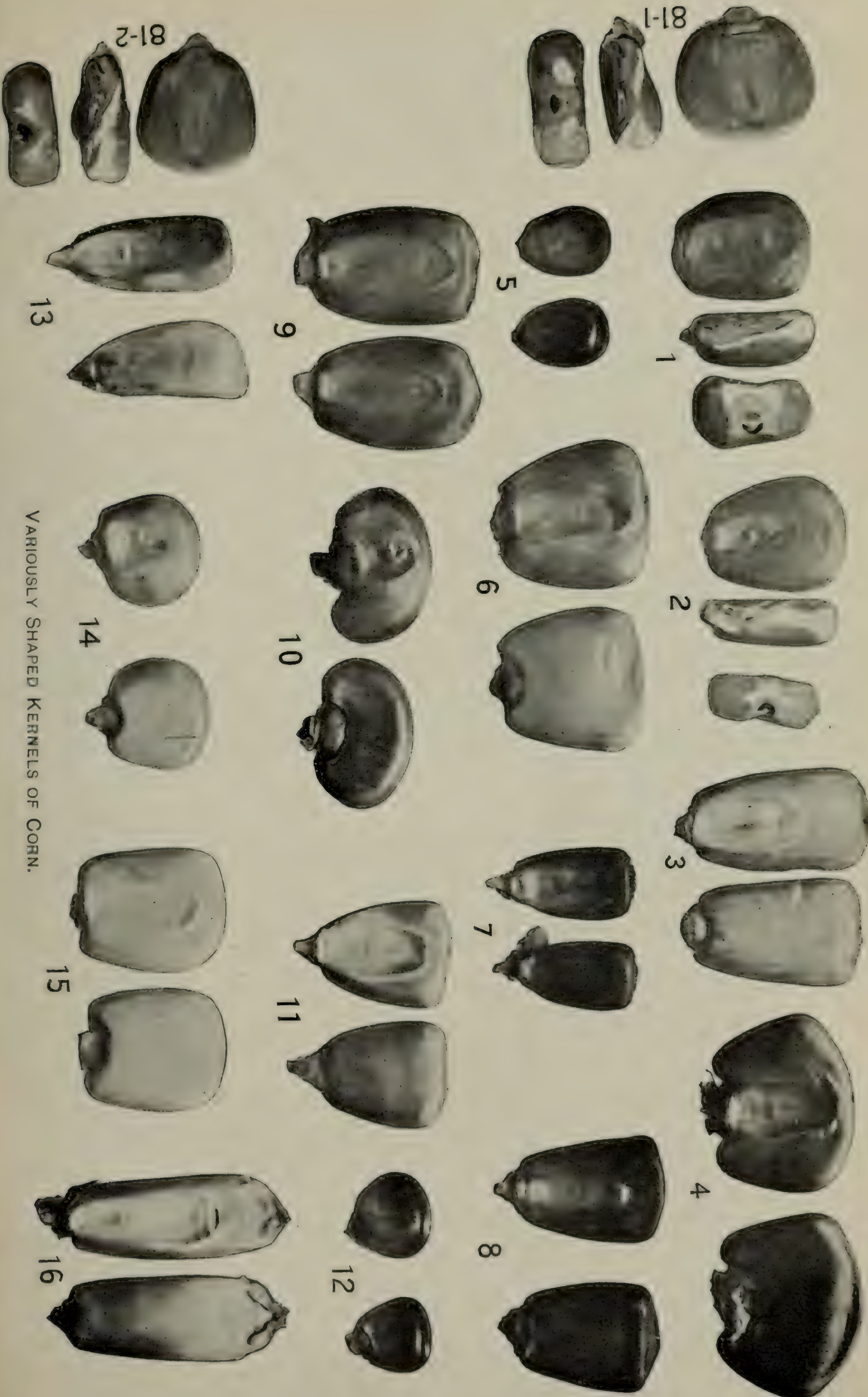


FIG. 1.—BARREN AND PRODUCTIVE STALKS OF CORN.

FIG. 2.—PROGENY STALK, SHOWING TRANSMISSION OF BROAD-LEAFED CHARACTER.

FIG. 1.—PARENT STALKS OF CORN.

FIG. 2.—PROGENY IN CENTRAL ROW FROM STALKS SHOWN IN FIG. 1.



VARIOUSLY SHAPED KERNELS OF CORN.

in its percentage of shelled corn. For this experiment four flint and two dent ears were selected, two of the flint ears being low and two high in percentage of shelled corn for that variety. The two ears of the dent variety did not differ very greatly. The following table gives the percentage of shelled corn of each of the seed ears and the percentage of shelled corn of the entire progeny of each seed ear, the diameter of the cobs of the seed ears, and the average diameter of cobs of the progeny:

Transmitting qualities of individual ears of corn.

Type.	Selection number of seed ears.	Percentage of shelled corn of seed ears.	Percentage of shelled corn of all progeny ears.	Diameter of cob of seed ears.	Average diameter of cob of progeny ears.
				Inches.	Inches.
Flint	85-2	73.1	73.8	1.37	1.27
	85-1	73.2	74.6	1.37	1.24
	85-3	81.1	77.1	1.00	1.10
	85-4	84.6	78.5	1.12	1.11
Dent	86-1	83.4	82.4	1.12	1.15
	86-2	85.1	84.7	1.12	1.16

A study of the above table shows that each seed ear transmitted its characters to its offspring. Another test of seed ears with reference to their length has shown that the longer the seed ear the greater was the average length of ear of the progeny.

While it is true that the kernels of an ear vary somewhat in regard to the size of germ, there is nevertheless considerable uniformity, so that ears can be selected having kernels with large germs, and consequently rich in oil and proteids, other ears of the same corn having kernels with small germs. Last spring large-germed and small-germed ears were selected from several varieties of corn and planted to test the degree to which the germs of large and small sizes would be transmitted. The harvest has shown that, almost without exception, the germs of the progeny of the large-germed ears are plainly larger than those of the progeny from the small-germed ears. Pl. LXXIV, fig. 81-1, shows longitudinal and cross sections of grains from a large-germed seed ear, and Pl. LXXIV, fig. 1, shows similar sections from an ear produced by this seed ear. Pl. LXXIV, fig. 81-2, shows sections of a small-germed seed ear, and also (fig. 2) sections from an ear produced from it.

It has just been shown that seed corn transmits the characters of the stalks from which it is gathered, and also that the characters of the seed ears themselves reappear in the ears harvested. It will now be shown that the various kernels of an ear possess an individuality that is transmitted to their progeny.

Pl. LXXV, fig. 1, shows a remarkable ear occurring in a field of white

dent corn which had for many years been grown as a reasonably pure corn, but which occasionally, as many white corns do, produced a red ear. This particular ear was red, but bore a white spot which covered about one-fifth of its surface. The kernels composing the white spot, although appearing very white in contrast with the red ones, revealed on closer examination fine red lines, or streaks, radiating from the caps down the sides of the kernels. These two types of kernels from this spotted ear were planted in separate rows. The red kernels produced a crop of 84 red ears, one of which is shown in Pl. LXXV, fig 4, and 86 pure white ears, like that shown in Pl. LXXV, fig. 3. The white kernels with fine red stripes produced 36 pure white ears and 39 ears having kernels like those planted, one of the 39 being shown in Pl. LXXV, fig. 2. In other words, each of the two types of kernels produced a crop of ears about 50 per cent of which had kernels like those planted, the remaining ears in each case being white.

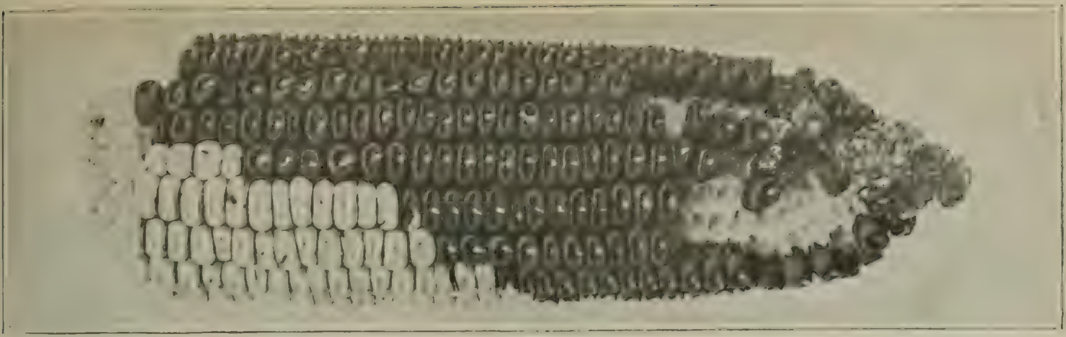
The above experiment illustrates the behavior of kernels on an ear that can properly be called a "sport" or sudden variation from the type. From the following it will be noticed that the various kernels of a hybrid ear follow the same rule of transmitting their individual characters. In 1900 a shoot on a stalk of Pedrick's Perfected Golden Beauty corn was pollinated with pollen from a hybrid of Pedrick's Perfected Golden Beauty and Cuzco. The immediate effect of this pollen was the production of an ear with three-fifths of its kernels of the normal yellow color, the remaining two-fifths having been changed by xenia, or the immediate effect of pollen, to various shades of plumbeous and purple. These two types of kernels were planted separately in 1901. Those of various shades of plumbeous and purple produced ears with about equal numbers of yellow, yellowish, and plumbeous kernels, as is shown by the three ears on the left in Pl. LXXVII. Of the ears produced by the yellow kernels more than half had only yellow or yellowish kernels, as is shown by the two ears in Pl. LXXVII, *E* and *F*, while the remaining ears had some plumbeous kernels. In 1902 kernels from the hand-pollinated ear shown by *F* produced a crop having no dark kernels whatever, and the plumbeous kernels from the hand-pollinated ear shown by *B* produced ears, all of which were much like the one shown by the same figure. It is thus seen that the color of corn kernels is fully under the control of the person selecting seed, and that ears of the desired color can be obtained in a very few years.

POINTS TO BE CONSIDERED IN MAKING SELECTIONS.

Since the kind of crop harvested depends so much upon the kind of plants from which the seed is selected, it is of vital importance to give great attention to the process of seed selection.

STALKS.

No accurate description can be given in a general paper of this kind of the type of stalk from which to select, for the corn must suit



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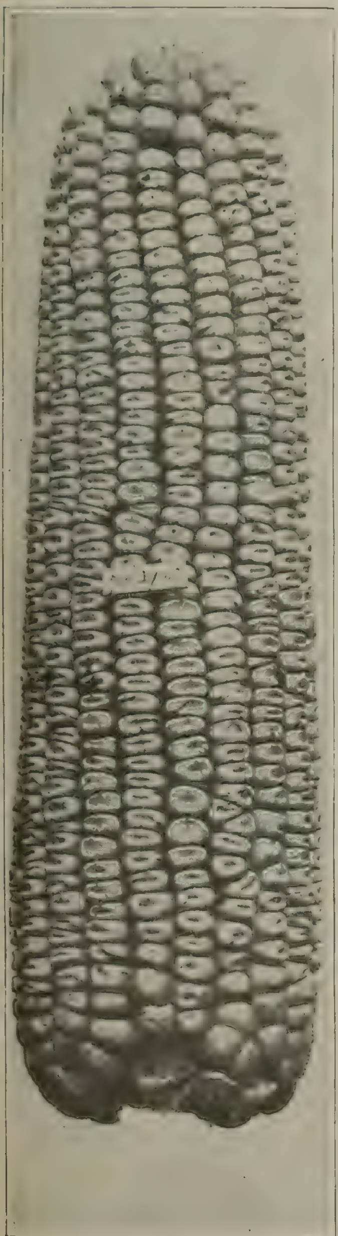
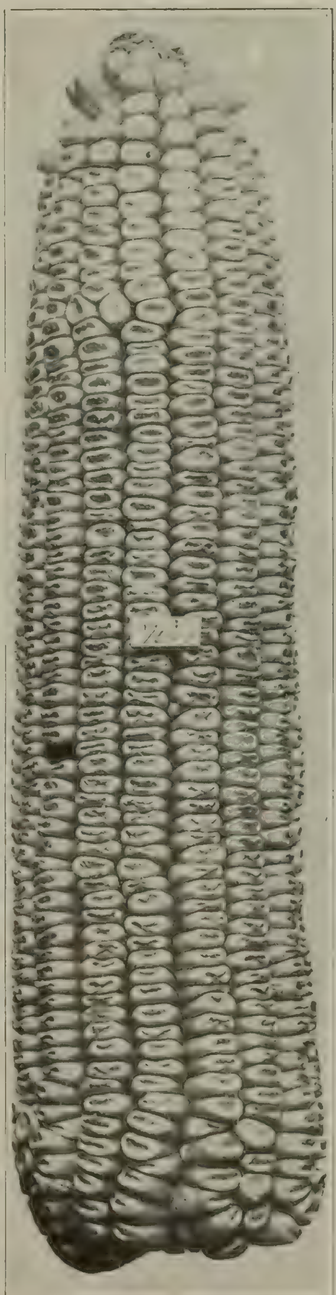
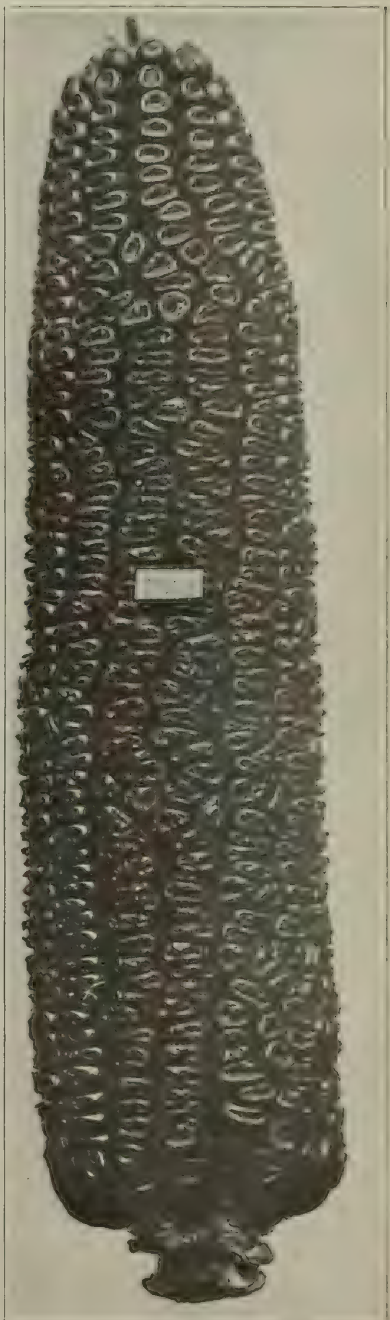




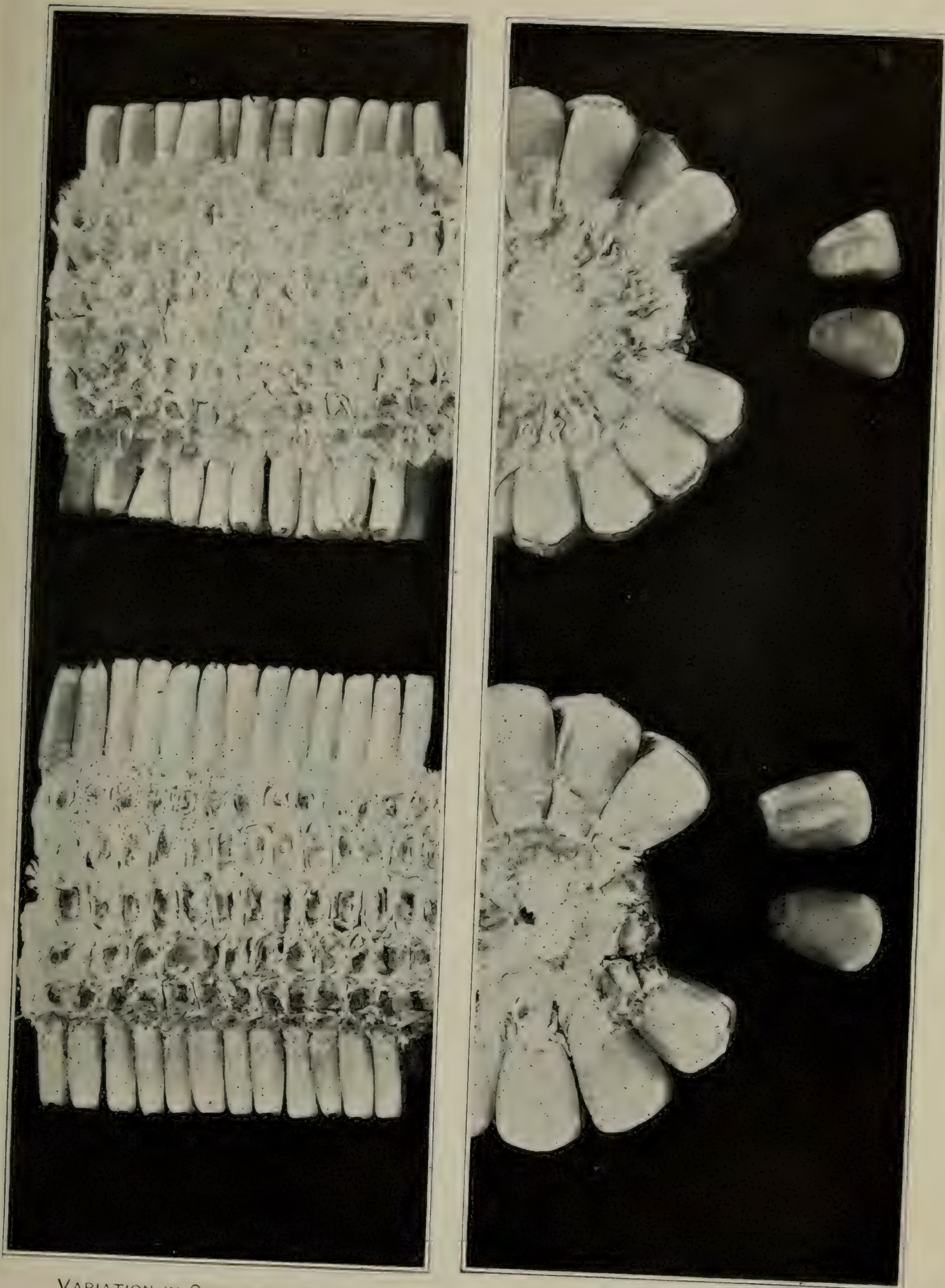


2. 3. 4.

PARENT EAR OF CORN AND SPECIMENS OF PROGENY.

[*1*, Seed ear planted; *2*, *3*, *4*, types of ears harvested.]

PLATE LXXVI.



VARIATION IN SIZE OF COB AND LENGTH OF KERNELS OF TWO EARS OF THE SAME VARIETY OF CORN.

the purpose for which it is grown. For ensilage purposes the stalk should be rich, succulent, leafy, and remain green and tender until the ear has reached considerable development; but if ear corn is the only product desired, the qualities of the stalk should be such as will best lead to the proper development and support of one or more good ears. The productiveness of a stalk is, of course, the point of most importance. A stalk great in circumference near the ground and tapering gradually to the tassel, with sufficient foliage of vigorous appearance, free from diseases and bearing a good ear or ears at a convenient height, is a desirable stalk from which to select seed. A thick, stout stalk can withstand extremes of weather for a longer period and with less injury than a slender stalk, and is less apt to blow down and cause the ear to decay on the ground. The height at which the ear is borne is a point of considerable importance, and seed selection with reference to this point is governed by the locality. In Missouri, Tennessee, Mississippi, and fertile districts in the South, ears are produced so high with some varieties as to make the work of shucking very laborious, while in Minnesota and North Dakota, where the ears are borne but 1 or 2 feet from the ground, the desire of growers is to obtain a corn that will ear high enough so that corn harvesters can be used to cut the corn below the ears. Besides the difficulty of gathering ears that are high up on the stalk, when in such position they exert an increased strain on the stalk and render it more liable to be broken by windstorms. At one locality in Ohio where the Department of Agriculture is carrying on selection work with one variety, measurements of many stalks showed that large, well-developed ears varied from a height of 3 feet to 8 feet from the bottom of the stalk.

If the corn is to be shucked by hand and shelled or sold for milling purposes a variety that produces one large ear to the stalk can be most economically grown, but if shredders are to be used and the ears are to be fed to cattle, a variety that produces a greater number though smaller ears per stalk will give better satisfaction.

EARS.

While in the field selecting seed ears one must always have in mind the type of ear toward which he is striving. It is a good plan to reserve for comparison an ear that comes nearest the ideal ear, but it must be remembered that the ideal ear will not be found, because no ear is in all respects perfect. Success depends on a strict adherence from year to year to the type it is desired to attain and fix. The leading qualities that will recommend the ears of a variety suited to most general purposes are: High percentage of shelled corn to cob; soundness of ears and kernels; high nutritive value of the kernels; uniformity in size and shape of ears; purity in color of grain and cobs.

The percentage of shelled corn of good quality is the most important character the ears can possess, because next after the productiveness

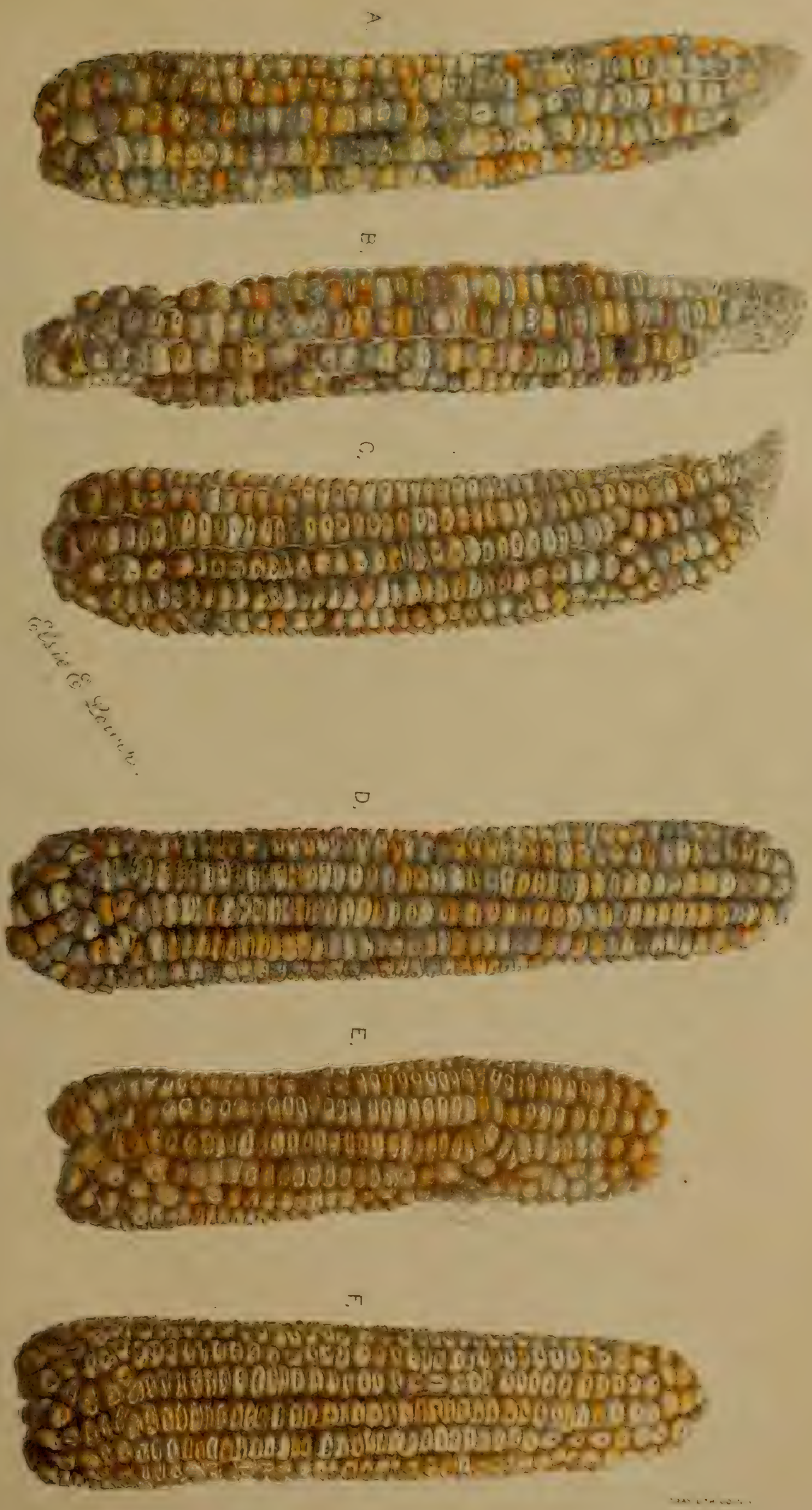
of the stalk it most influences the feeding value of a crop. Well-filled ears of different varieties vary from 75 to 92 per cent. Different ears of the same variety will vary 10 per cent in this respect because of the relation of the length of kernels to the size of the cob. Pl. LXXVI shows such a variation in a white dent variety. The proportion of grain to cob is influenced by the following: Length and solidity of kernels in proportion to size and composition of cob; filling out at butts and tips; space between the rows of kernels; uniformity in shape and arrangement of kernels.

While great weight of grain in proportion to weight of cob is highly desirable, it is not to be understood that it is advisable to have as small a cob as possible. The small-eared corn represented in Pl. LXXI, fig. 2, has rather too small a cob. The pressure of the kernels causes many of the cobs to break, allowing the tip portion of the ears to drop out of the husks before the harvest. A larger cob with proportionately longer kernels and less space between the rows of kernels would be a great improvement to this corn, and would not reduce its high percentage of grain. Many varieties have the failing of not filling out at the butts and tips, thus leaving one or more inches of cob destitute of kernels. Spells of dry weather may increase this fault, but under equal conditions varieties highly selected with reference to this point fill out better than do those not so selected. Pl. LXXVII, *A*, *B*, and *C*, although reproduced for another purpose, illustrate ears poorly filled at the extremities, while Pl. LXXI, fig. 7, shows a well-filled ear.

Other things being equal, ears with wide sulci, a name given to the space between the rows of kernels, and as illustrated in Pl. LXXI, fig. 5, will not yield as high a percentage of grain as ears with narrow sulci (Pl. LXXI, fig. 4). Neither can ears with crooked or irregular rows, which produce ill-shaped kernels (Pl. LXXI, fig. 8), have as high a percentage of grain as straight-rowed ears having kernels uniform in size, shape, and arrangement.

The necessity of having well-matured ears with dry, sound kernels and cobs is so great that it is not apt to be overlooked by even the most careless grower; but if it should be, it is brought to his attention when the crop is offered for sale. A variety that matures properly and is sound in one locality is frequently found to be unsuited to a more humid climate, the ears becoming soggy or moldy.

There are not a great number of varieties that have been selected sufficiently long and rigidly to fix them to distinct types that will enable them to be unmistakably identified; but that there are some such varieties proves the possibility of fixing a type. While it is desirable that a variety should have some distinctive characters of ear or kernel, it is not advisable for a breeder to select for a character that is subject to some objection. It is not necessary that all varieties should have cylindrical ears (Pl. LXXI, fig. 7), but this is the shape that best permits of a high percentage of grain and uniform size and



VARIATION IN CORN HYBRID.

FIG. 1.—PROGENY EARS RESULTING FROM PLUMBEOUS KERNELS SELECTED FROM AN EAR LIKE D.

FIG. 2.—TWO EARS ON RIGHT SHOW CHARACTER OF EARS PRODUCED FROM YELLOW KERNELS TAKEN FROM EAR LIKE D.

shape of kernels. If the ears are conical (Pl. LXXI, fig. 9), it is necessary that the grains near the tip be smaller or that some of the rows do not extend to the end, thus causing some kernels to be irregular in shape. Grains of irregular sizes and shapes can not be planted evenly with corn planters.

Manufacturers of white-corn goods prefer that the cobs be white, for in manufacturing white grits, meal, or flakes it is difficult to prevent some particles of cob from adhering to the kernels, and if the cob be red such particles show conspicuously and detract from the appearance of the finished product. For yellow corns, red cobs are not objectionable.

KERNELS.

The selection of seed ears having very long kernels is the best means of producing a corn with a high percentage of grain, but in selecting for long kernels quality must not be overlooked. Frequently the quality of kernel is very poor on ears having the longest kernels. Pl. LXXI, fig. 6, shows such an ear, and Pl. LXXIV, fig. 16, shows two kernels from this ear where the soft, chaffy nature of the apical portion can be noticed. The best shaped kernels are those of good length, which gradually broaden from the base or point of attachment on the cob to the cap, thus leaving the least space unoccupied. Pl. LXXIV, figs. 3 and 8, show well-shaped kernels for general-purpose corns. For the manufacture of hominy, hard kernels from which the germs separate readily, leaving the rest of the kernel in one large, flinty piece, are desirable. The flint ears, with their broad, round-capped, kidney-shaped kernels (Pl. LXXIV, fig. 10), yield a low percentage of grain, and are in many localities being discarded for longer-kerneled types.

Purity of color is one of the easiest results for the corn breeder to accomplish and is very desirable for milling corns. Some markets desire a golden-yellow meal and others a pure white, but there is no special demand for meal from a mixed corn.

As has already been shown, there is an individuality attached to each kernel on an ear, but it will seldom be practical for growers to make any distinction when shelling seed ears except to discard the small kernels at the butts and tips of the ears. It has been demonstrated by the Department of Agriculture that such kernels produce a greater percentage of feeble and nonproductive stalks than do the full-sized kernels from the same ears, and growers are recommended to "nubb" their seed ears. A good plan to follow when shelling seed corn is to remove the small kernels from butts and tips and shell each ear separately into a pan, so that the kernels can be examined before placing them with the seed from other ears. Where a large supply of seed is needed the ears can be nubbed by hand and shelled with a sheller.

IMPORTANCE OF A SEED PATCH.

Every grower who raises his own seed corn should plant his very choicest seed ears in an isolated patch from which to select his seed for the following year. If his farm does not admit of such an isolated seed patch, it can constitute a number of rows in a field of the same kind of corn, which, of course, should also be planted with choice seed. The seed patch should be located on the same kind of soil as that in which the seed selected from it is to be planted. If the corn is to be grown on upland clay soil, the seed should be selected from year to year from corn grown on similar soil.

The choicest ears should be planted separately in the seed patch. If the rows are long a row can be planted with seed from each ear. This separate planting is highly desirable, because some ears produce better than others and are those from whose progeny it is advisable to select seed for the next year. Not many, except those who have tried the plan, will believe that when a patch is so planted with individual ears of the same variety some rows will be so unlike as to be easily distinguishable. The seed patch should have uniform conditions of soil and drainage, so that the difference in production of the various rows will indicate the comparative productiveness of the seed ears. One of the many objections to selecting seed from a crib is that a large ear found there does not necessarily indicate the tendency of the parent plant to produce a large ear. It is not unlikely that the ear is large because it grew in a particularly fertile portion of the field, and may therefore be a much less desirable seed ear than a smaller one that grew under less favorable circumstances.

Some rows will be so feeble that it will be desirable to remove the tassels from all the stalks in them before the pollen is discharged. In the seed patch, the size of which will depend upon the amount of seed needed, all feeble, diseased, and nonproductive stalks should have their tassels removed before they shed their pollen; otherwise these undesirable stalks will furnish pollen that will fertilize some of the ears that may afterwards be selected for seed.

At the time the corn is tasseling it is not always easy to tell the stalks that will not produce ears, but if a stalk is in tassel and almost sufficiently advanced to discharge its pollen, and shows no shoot or indication of the formation of an ear, it is well to remove its tassel. An abundance of pollen is produced, so that the detasseling of all the poorer stalks to the extent of half the stalks in the seed patch will not interfere with good pollination. A short time after the pollen is shed it is easy to distinguish between barren and productive stalks. (Pl. LXXII, fig. 1.)

The work of the Department of Agriculture is yearly giving evidence that the removal of barren stalks from the seed patch reduces the percentage of barren stalks in the next year's crop. No field of well-selected corn, under average conditions of weather and cultivation,

should contain more than 4 to 5 per cent of barren stalks. In the fall of 1902 a count of 25,507 stalks showed that a field planted with seed gathered from a seed patch from which most of the barren stalks were removed in 1901 contained 3.43 per cent of barren stalks, while two other fields of the same corn, under the same conditions of soil and cultivation, but planted with seed from the crib, contained 8.11 per cent of barren stalks.

TIME AND MANNER OF SELECTING SEED.

If it is desirable to have the variety mature earlier, it is necessary to perform seed selection just as soon as the corn begins to ripen, and to select ears only from the early maturing stalks. On the other hand, if a later maturing corn is wanted, the selection should be performed after the corn is quite ripe, seed being taken only from stalks still remaining green. If the variety is thoroughly acclimated, so that it occupies all the good growing season and ripens at the proper time, the selection can be made at any time after the corn is ripe and before freezing weather. There seems to be quite a general demand throughout the country for earlier maturing varieties, but it should be remembered that the shorter the season of growth the less chance the corn has of growing a heavy crop. In general, the early varieties are less productive than varieties requiring longer growing seasons.

Some farmers have adopted the plan of selecting their seed while gathering their corn from the standing stalks, having a box in the wagon into which are thrown the good ears as they are found. While this is much better than no selection, it is only doing in an easy manner what might be better done. One can do work better by giving his whole attention to one thing at a time, and no one can do a good day's work husking corn and at the same time find the best seed ears in the field.

The seed patch having been planted as above described, the rows that have not produced well can be entirely ignored and seed taken only from those rows whose general appearance shows that they were planted with seed from desirable ears. By passing along these productive rows, the attention will be attracted by good stalks bearing good-sized ears at the proper height, and if, after stripping back the husk of such an ear, it proves desirable, it can be gathered, placing all ears from each seed row in a separate sack, on which is placed the number of the seed row. After this each seed row can be shucked separately, throwing the corn into a wagon and weighing it. By this means the most productive rows in the entire patch will be determined, and the seed already selected from them and sacked can be used in planting a similar seed patch next spring, while the other sacks of seed selected can be used for the general planting. This process of seed selection may impress some as being too tedious, but if properly performed it will be found highly profitable. When it is remembered that an acre

planted with seed from a dozen good ears will produce 10 or perhaps 20 bushels more than if planted with poorer seed, it is readily seen that it is worth considerable effort to obtain good seed ears.

KEEPING SEED CORN THROUGH THE WINTER.

After having been properly grown and selected, seed corn may be greatly reduced in vitality by injudicious care during the winter. It is the vitality of the seed and the nutriment stored in the seed that sustains the young plants during their first week of growth, and the success of a crop depends much upon the vigor with which the young plants begin growth. By those who take pains to select seed in the fall, not many serious mistakes are made regarding its preservation, although some do not give the seed as good treatment as they might easily do. Any means that secures a thorough drying of the seed ears soon after they ripen, before freezing weather, and keeps them dry until the seed is planted will be a success. It must be remembered that although seed corn is thoroughly dried, it will not remain so if exposed to a saturated atmosphere. The kernels absorb moisture, and if exposed to changes in temperature while moist, their vitality will be injured. A thorough drying of seed ears, by artificial heat if necessary, and their preservation in a dry atmosphere and at a steady temperature, is strongly recommended. During the past year seed dried by fire and kept dry and at a steady temperature during the winter was planted, in comparison with seed from the same fields which was suspended in barns at husking time and left exposed to atmospheric conditions of temperature and moisture. The tests were made on different soils and in different States by planting 10-acre patches, so that the well-preserved or fire-dried seed was planted in alternating rows with the air-dried seed, that is, a row was planted with fire-dried seed and then one with air-dried seed, and so on throughout the 10-acre fields. There was no perceptible difference in the rapidity of germination; 70.9 per cent of the air-dried and 73.8 per cent of the fire-dried seed grew and survived. These percentages were obtained by counts made after the plants had reached a height of about 8 inches. A count made at harvest time proved that the stalks had increased by growth of suckers 19.7 per cent in the "air-dried" rows and 29.4 per cent in the "fire-dried" rows. The crop from each row was weighed separately, and in all cases each "fire-dried" row produced more and better corn than the "air-dried" rows on either side of it. The greatest difference was on good soil on the Potomac River bottoms, where the fire-dried seed produced 18¼ bushels more corn per acre, the average yield from the "fire-dried" rows being 85.59 bushels of ear corn per acre, in comparison with 67.34 bushels from the "air-dried" rows.

Although all the rows were planted by hand, with 3 kernels in every hill, and germinated almost equally well, as above shown, at harvest

time the "fire-dried" rows contained 12.5 per cent more stalks than the "air-dried" rows. This, however, was not the leading cause for the increased production, for the total average production per stalk in the "fire-dried" rows was 0.672 pound, as compared with 0.618 pound per stalk from "air-dried" seed.

On upland clay soil "fire-dried" seed produced 63.92 bushels per acre, while "air-dried" seed produced 56.88, a difference of 7 bushels in favor of the seed that had special care taken of it during the winter.

While it may not be practicable for all growers to keep their seed corn dry throughout the winter by means of fire, it is possible for all to dry the seed ears thoroughly in the fall and then place them where they will remain dry and not be subjected to extreme weather conditions.

ADVISABILITY OF BUYING SEED CORN.

Many growers entertain the idea that the growing of the same corn for years on one farm will cause it to "run out." Such is not the case. It is the lack of attention to seed selection that causes the deterioration and not the continued growing of the same corn on one farm. It is true that the corn on many farms does become poorer from year to year. Such is likely to be the case where any farmer who gives no attention to seed selection or the detrimental effects that may follow cross pollination, or mixing, starts with highly bred seed and expects the corn to retain indefinitely its good features without yearly attention to the principles of proper seed selection. It is the inherent tendency of plants to vary that makes improvement possible, and whether the strain of corn grown on any particular farm shall become poorer or shall become better year by year depends on whether seed below or above the average of the strain is yearly selected. Carefully conducted experiments prove that it is possible to make corn poorer in quality and productiveness by the selection of seed from poor individuals; and those who use their best corn during the winter and plant such as is left in the spring, and those who eat as roasting ears the earliest and best ears in the patch and take their seed from such as remain, are constantly repeating these experiments. It is no wonder their corn becomes poorer, or, as it is commonly expressed, "runs out."

It is deemed highly advisable to improve a corn in the district and on the kind of soil where it is to be afterwards grown. It is true that a well-bred variety may sometimes be sent hundreds of miles from the place where it was improved and there be found superior to the native varieties with which it comes in comparison, while, on the other hand, a change in the conditions of soil and climate may cause a change in the corn or its habits of growth, so that a valuable variety for one State may be worthless for another State. For this reason extensive importation of seed corn from another locality where the

soil and climatic conditions may be different should not be made without first testing the variety on a small scale.

To produce a desirable grade of seed corn requires considerable attention and work, but the better quality and larger quantity of corn that will grow from it will more than pay for the labor. Any corn grower who has not the time, ability, or a suitable location to grow and select seed corn of a high grade should each year buy his seed and willingly pay several dollars a bushel for it, but he should be sure that the seed he buys has been properly bred and selected. One safeguard in buying is to insist that the seed be delivered as ear corn. Sellers of seed corn offer several reasons for their unwillingness to ship seed corn on the ear, but if honestly expressed the chief reason would be that by so doing they are unable to dispose of poor and small ears. When viewed in the proper light there are no good reasons that will prevent the selling and shipping of seed corn on the ear, and certainly as much profit can be made by selling good seed corn at an advanced price as by selling for seed purposes and at low prices corn which it is unwise for anyone to plant. The reform can best be accomplished by all who buy seed corn insisting that it be delivered on the ear. Growers can then at least know from what kind of ears their seed was shelled. Seedsmen find it to their profit to meet the demands of their patrons, and if the demand for unshelled seed corn becomes great they will of necessity meet the demand. As soon as it becomes the universal practice to accept no seed that has been shelled a great step will have been taken toward the raising of the average production per acre, for it will take from unscrupulous men one means of imposing upon the growers by the sale of poor seed.

Properly grown and selected seed will often produce 15 bushels more corn per acre than unselected seed of the same variety. A bushel of seed will plant 6 or more acres, so that, estimating corn at 30 cents per bushel, such seed corn bears a money value of $27 per bushel.

FERTILIZERS FOR SPECIAL CROPS.

By A. F. Woods and R. E. B. McKenney,

Of the Bureau of Plant Industry.

INTRODUCTION.

In the Yearbook for 1901 a paper was presented dealing with nutrition in its relation to the health of plants. An attempt was made to present the general principles from the standpoint of the physiology of the plant so far, at least, as these principles might have a direct or indirect practical bearing. The growing of crops under glass has come to be a more or less highly specialized business. In fact, the work is more than a business—it has become an art as well. Many millions of dollars are invested in the work and thousands of men are devoting their best energies to the production of plants reaching nearer and nearer to the highest standards. To get an idea of how successful these workers have been, one needs only to bring to mind some of the wonderful creations among roses, carnations, and chrysanthemums. But after a plant has been produced with ideal possibilities, it will reach its best and hold its own only with the most intelligent care. A plant is much more than a delicately balanced machine; it is a sensitive living being, with its likes and dislikes and individual peculiarities. The successful grower must learn to interpret its silent language and to meet its varying wants, molding it to his ideal, or, perhaps, to other people's ideals, according to the demands of the trade.

Among all the questions to be dealt with there is no one more important than feeding. What to feed, when to feed, and how to feed, are questions often asked, and we have to depend for answer upon the experience of expert growers and experimenters. While there is a very great deal yet to be learned by careful experiment in this field, a concise statement of the general practice in feeding certain crops may not be without interest and value.

The questions of temperature, watering, and ventilation are extremely important in connection with feeding, but they can not be discussed in this paper.

Experienced growers of the crops discussed will find in these pages simply a concise statement of facts already familiar to them. All available published matter, including notes in American and foreign

periodicals and books[a] on feeding the crops in question, has been reviewed in preparing this paper, and a number of leading growers have kindly furnished data regarding their methods. An effort has been made to systematize the various methods and terminology in order to determine the most approved practice. As stated above, however, plants can not be grown by rule; experience and individual experimenting along conservative lines are necessary to success in the culture of any crop. Attention will be directed especially to crops forced under glass, including roses, carnations, chrysanthemums, violets, tomatoes, and lettuce.

ROSES.

SOIL.

A great variety of soils can be successfully used for forcing roses, but a moderately heavy loam from rotted sod is generally recommended. The lighter types are most favorable, according to Hunt,[b] for such varieties as Perle des Jardins, La France, Duchess of Albany, and Niphetos, while a good stiff loam is required for Brides, Mermets, Madam Hoste, Gontier, Souv. de Wootton, and American Beauty. If the right type of soil can not be found, light and heavy soils can be mixed to secure a soil of the desired texture. Assuming, however, that the proper sod loam can be found, cut the sod in the fall and compost with cow or horse manure, using 1 part manure to 3 parts soil. Turn and mix this pile two or three times during the winter, breaking up all lumps and getting into good, even condition. At the last turning, which should be made several weeks before the compost is to be used, add 10 to 15 pounds of fine-ground bone, free from common salt, to each cubic yard of compost. This should be thoroughly mixed. Fine-ground steamed bone is best for greenhouse use, as it decays more quickly than raw bone, and its phosphoric acid thus becomes available earlier. If raw, coarse bone is used, only a small part of the phosphoric acid becomes available during the first season, but the nitrogen content is a little higher.

It is also safe and desirable in the case of roses to add to the bone some form of potash, especially in the lighter types of soil. About 1 pound of muriate of potash, or 6 quarts of good wood ashes, to the cubic yard, applied with the bone, is sufficient for the compost, which

[a] There are numerous very valuable special publications on fertilizers that should be consulted by those interested in the subject. Some are cited in other footnotes in this paper. In addition, Bulletin No. 94, new series, New York Agricultural Experiment Station, "Composition and use of fertilizers," will be found especially valuable. There are also numerous articles in the American Florist, Florists' Exchange, and other periodicals of this nature. Agriculture, by Storer, and Fertility of Land, by Roberts, also contain very helpful and suggestive matter on this subject.

[b] How to Grow Cut Flowers, pp. 47–50.

must not be too rich to start with, or the roots of the young plants will be injured. After the plants get a good start and the soil is filled with roots additional food will be required. The compost prepared as stated is adapted for plants from 3-inch or 4-inch pots.

The potting soil used for the plants up to the time they are ready for the beds should be very thoroughly rotted sod soil, as described above, mixed with one-sixth to one-eighth thoroughly rotted cow manure or horse manure, but with no bone or so-called chemical fertilizers.

SOIL STERILIZATION.

It is best, if possible, to sterilize the potting soil with steam from a high-pressure boiler. This will destroy the plant and animal parasites likely to injure the young plants, so that they will usually be able to take care of themselves when set from the pots to the beds.

Some of the most successful growers also sterilize their compost soil for the beds. If this is properly done it destroys all nematodes, grubs, and all plant and animal parasites likely to attack the roots, as well as all weed seeds. In large establishments, at least, it will certainly pay to sterilize all soil used, especially where nematodes or other root parasites occur.

The usual method of sterilization for greenhouse use is to build a large bin, about 4 feet wide by 10 or 15 feet long and 3 feet deep, running pipes though the bottom of the bin (or through the bin a foot from the bottom) a foot apart lengthwise. In a 4-foot bin there would be three pipes, with one-sixteenth inch holes drilled in them on the under side, about 1 foot apart. Fill the bin loosely with soil, turn in steam of about 80 pounds pressure, put a few potatoes in the top of the soil, an inch or so under the surface, then cover the surface with tight boards, burlap, or cloth, in order to prevent escape of the steam. Usually one or two hours under good pressure, if the soil is not too heavy, will cook the potatoes in the top of the soil; then one may be sure that the parasites and weed seeds have been destroyed. If high-pressure steam is used the soil will dry rapidly after the steam is turned off, and can be shoveled out of the bin without much difficulty, especially if one side of the bin is removable.

In sterilizing soil without the use of a bin about the same process is used. The pipes are laid in the ground to be sterilized in about the same manner as in the bin. If it is desired to sterilize about a foot of soil, the pipes should be placed under the soil about a foot, with the drill holes on the under side; the surface should then be covered with boards, burlap, or something to prevent the escape of the steam, and the soil should, of course, first be loosened, so that the steam can circulate through it. A few potatoes distributed over the area will tell when the sterilization has become complete. After the sterilization, the pipes can be removed. It is a good plan before sterilizing

to mix in the manure that is to be used, as this often contains numerous weed seeds. If commercial fertilizers are used, of course it is not necessary to add them first.

Any small high-pressure boiler will serve to make the steam. Some use a small independent boiler for the purpose; others attach the apparatus to their high-pressure boiler. A low-pressure boiler is usually unsatisfactory, as it takes a longer time to circulate the steam; it leaves the soil wet and soggy and does not do the work very well.

Soil sterilization is rapidly coming into favor for all intensive work where the process is practicable.

FEEDING WITH ORGANIC OR BARNYARD MANURES.

After the plants are set in the beds no feeding is advisable till growth has started vigorously and the soil is filled with roots; then mulch with not over one-half inch well-rotted and properly sterilized sheep, cow, or horse manure. This first mulch should be followed by a second one as soon as the first is used up by the plants. Subsequently, especially during the middle of winter (December and January), the plants should not be mulched, but liquid manures should be used. These may be either liquid organic manures or the so-called chemical fertilizers, or combinations of both. Animal manures, unless carefully saved and protected from leaching and excessive fermentation, are not rich, and are variable in their fertilizing value.[a] Barnyard manures are most effective and valuable when composted or mixed with the soil or when used in a well-rotted state as a mulch for growing crops. Rapidly fermenting manure will injure the roots of almost any plant. Liquid manures should therefore be made from materials that have already fermented or rotted under such conditions as to conserve their fertilizing value. The following proportions will make good solutions: Ten pounds of pulverized sheep manure to 50 gallons of water; or 20 pounds of cow or horse manure, when in a comparatively dry condition, to 50 gallons of water, or 3 to 5 pounds of hen manure to 50 gallons of water. The best way is to put the manure in a coarse gunny sack and soak it in water for several days, sousing the sack up and down occasionally and mashing it with a blunt stick, so as to thoroughly break up the contents. Strong growing plants with good root systems will be benefited by feeding with such manure solutions once in ten days or two weeks during the periods of most active growth. When growth is slow or checked by cold or cloudy weather, feeding should be discontinued till active growth again indicates its need. This is most likely to be in March and April.

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[a] See Farmers' Bulletin No. 21, U. S. Dept. Agr.

OVERFEEDING.

There is much greater danger of overfeeding than underfeeding. If there are indications of overfeeding, sow on the beds some quick-growing grass or some other quick-growing plant that will take out some of the excess of plant food; also give a liberal coating of gypsum, which will counteract an excess of soluble salts. When the weather is favorable an excess of soluble material in the soil can be reduced by thoroughly drenching it with water.

FEEDING WITH COMMERCIAL FERTILIZERS.

While it is perhaps safer to rely on organic or barnyard manures with bone and wood ashes to supplement them in phosphoric acid and potash, roses as well as other crops can be grown without manures by the use of commercial fertilizers. Commercial fertilizers where used in connection with organic manures will first be considered.

It is safest to use quick-acting and easily soluble fertilizers like nitrate of soda, superphosphates, etc., in soils containing a good deal of fibrous material, leaf mold, or partially decayed vegetable fiber, which will absorb the fertilizer and give it up slowly to the roots. In a compost made as described above, feeding with manure solution can be profitably alternated with commercial fertilizers. If the vegetative growth needs stimulating and brightening and the plants have strong root systems, give a feed of nitrate of soda—10 ounces to 50 gallons of water per 100 square feet of area. If the plants do not have strong, vigorous-feeding roots, and especially if the soil is not rich in fibrous material, use 6 ounces to 50 gallons of water. Continue at intervals of ten days to two weeks till growth is active and the foliage is of good, rich color. If growth is active and of good color but spindling and soft, the need of potash and lime is indicated and nitrogen should be avoided in this case. Potash may be supplied by giving a light coating of good wood ashes, 1 pound to 20 square feet of bench. Or if good wood ash is not available, sulphate or muriate of potash can be used, at the rate of 8 to 12 ounces to 50 gallons of water per 100 square feet of bench, at intervals of ten days to two weeks, or sprinkled dry at the same rate per 100 square feet. When either sulphate or muriate is used it should be followed after the second or third application by a sprinkling of lime, about 1 pound to 20 square feet. When the growth is plump and solid use only the ordinary manure water when needed. If the plants are growing well but are not making flower buds, cut down on nitrogen and give phosphoric acid either as steamed fine bone, free from salt, at the rate of 1 pound to 20 square feet; or, if it is desirable to avoid the nitrogen of the bone, give a dressing of superphosphate, 1 pound to 100 square feet, and follow in a few days by lime as above. The superphosphate may be applied in water, using 1 pound to 50 gallons of water for 100 square feet. If there is reason to believe that there is a general lack

of plant food, a complete fertilizer should be used, alternating with manure solutions. Voorhees[a] recommends one-fourth pound nitrate soda, 1 pound acid phosphate, and one-half pound muriate of potash for 100 square feet of area. Unless soil conditions are favorable and the roots strong, the amount mentioned is a little too high. A pound of the mixture per 100 square feet is safer. The amount of available water in a square foot of moist loam 6 inches deep (one-half cubic foot) is approximately 5 to 7 pounds (or pints),[b] or for 100 square feet from 500 to 700 pints or pounds. At this rate 1 pound of material in solution in the 50 gallons of water (about 1 to 400) would add 4.8 grams (72 grains), or approximately one-sixth of an ounce to each square foot (6 inches deep). Counting the water in this amount of soil under the most favorable conditions for growth as 5 to 7 pounds per square foot of bed, there will be a soil solution (assuming that what is added remains largely in solution) of from 1 to 500 or 1 to 700. This is as strong as most plants will stand without more or less injury to the feeding roots. It is too strong to risk such very soluble and active materials as nitrate of soda, nitrate of potash, and muriate of potash, but is safer for superphosphates or sulphate of potash, as recommended above.

It is unsafe to use chemical fertilizers or liquid manures in full strength on a heavy soil which is not provided with sufficient fibrous material.

Stuart, of Indiana, recommends as a complete fertilizer for roses the following mixture: Superphosphate, 130 pounds; ammonium sulphate, 13 pounds; sodium nitrate, 31 pounds; potassium sulphate, 26 pounds. He recommends 1 ounce of this mixture to 1 gallon of water for 2 square yards of bench surface once a week as the plants need it. This is equivalent to 3 pounds to 48 gallons of water (approximately a barrel) applied to 864 square feet of bench surface, or about 6 ounces to 50 gallons of water for 100 square feet. This is the right strength for weak plants. Twelve ounces could be used to 50 gallons of water per hundred feet for strong plants once in ten days or two weeks, as the plants need it. It is safer to use the 50 gallons per 100 feet standard of application, as this is about the amount of water usually applied in an ordinary watering to 100 square feet of bed 6 inches deep.

Stuart has recommended the following as quick-acting plant food mixtures, differing only in the sources from which the food elements are obtained:

(I) Sixteen ounces nitrate of soda, 10 ounces potassium sulphate, 20 ounces disodium phosphate.

(II) Five ounces nitrate of soda, 20 ounces potassium nitrate, 20 ounces disodium phosphate.

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[a] Fertilizers, 1902 ed., p. 327.

[b] See "Water as a factor in the growth of plants," Yearbook of the Department of Agriculture for 1895, pp. 94–168.

(III) Sixteen ounces nitrate soda, 10 ounces potassium sulphate, 33 ounces acid phosphate, containing 12 per cent of available phosphoric acid.

Either one of these may be used at the rate of 8 to 12 ounces of the mixture to 50 gallons of water per 100 square feet of bench, the strength of the solution depending on the vigor of the plants.

Wagner's solution has given good results for roses as well as carnations and other crops. It is made as follows: Phosphate of ammonia, 2 ounces; nitrate of soda, 1¾ ounces; nitrate of potash, 1¾ ounces; sulphate of ammonia, 1⅓ ounces; water, 50 gallons.

C. W. Ward,[a] at the last meeting of the Society of American Florists, recommended some valuable formulæ for general use based on his own experience, and has given in a very concise manner the general principles governing their use.

Various other combinations of sources of nitrogen, potash, and phosphorus may be used at about the same rate of total soluble material for 100 square feet of bed 6 inches deep. The proportion of each food element must depend upon the need of the crop. It is necessary to consider the total soluble materials (salts), as well as the total available food, when figuring on the strength of solution to use. This is because, as previously explained, roots are often injured when the amount of salt in solution, whether food or other kind, exceeds a certain limit, that is, about 1 part by weight in 400 of water, for ordinary crops, though this varies more or less, according to the crop grown, nature of the salts in question, soil conditions, etc.[b]

If desired, the organic-manure solutions may be discarded and only chemical fertilizers used. Manure may also be left out of the soil and chemical fertilizers substituted. Voorhees[c] recommends for forcing house crops in general when a good loam of reasonable fertility is used: One-half pound nitrate of soda, 1 pound acid phosphate, 1 pound ground bone, one-half pound muriate of potash. This is to be thoroughly mixed in the soil for each 100 square feet of bench at the time of filling, with subsequent feeding, as in the case of regular compost. He recommends for roses and other flowering plants where phosphates are especially desirable, 4 parts ground bone and 1 part muriate of potash at the rate of 2 pounds of the mixture per 100 square feet of area, well worked into the soil previous to setting the plants. Later feeding may be followed as in regular compost soils.

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[a] Proceedings Eighteenth Annual Convention, Society American Florists and Ornamental Horticulturists, August, 1902.

[b] For a general discussion of the relative value of various fertilizers, see Farmers' Bulletin No. 44, U. S. Dept. Agr.

[c] Fertilizers, 1902 ed., p. 327.

VIOLETS.

SOIL.

Violets do well in good clay loam such as is used for roses, or in a sandy or gravelly loam. A sandy type of soil, however, should contain abundant fibrous matter from decayed grass roots or manure, or should have about one-sixth of good leaf mold mixed with it at the time of preparing the beds for the young plants.

The amount of manure needed in the compost must be determined by the richness of the soil. A good, rich clay loam requires 1 part cow or horse manure of good quality, three to four months old, to 4 parts of soil composted as for roses. It is best not to add any bone or other fertilizer. The compost should be thoroughly limed as made up, a good sprinkling of lime to each layer of soil. The manure should be thoroughly incorporated with the soil by the time the latter is put into the beds. Thorough steam sterilization of the soil will kill root nematodes, cutworms, root-rot fungi, spores of Botrytis, and numerous other parasites and pests that trouble the violet grower.

Lighter types of soil will take 1 part manure to 3 parts soil; otherwise they are to be treated the same as above mentioned. The greatest danger in violet growing is in getting the soil too rich.

LATER FEEDING.

The amount of nitrogen, phosphorus, and potash removed from the soil by a crop of violets is very small, and if good soil and manure are used no further feeding is necessary or desirable. If, however, feeding should become necessary for any reason, it is safest to use manure water made from cow manure, or well-fermented horse manure, as recommended for roses; but it should not be used oftener than once in three weeks, and only during active growth or when active leaf growth is desired. If there is indication of a lack of phosphoric acid, shown by reddening of the leaves along the veins and a tardy development of flowers, use steamed fine bone, free from salt, at the rate of 1 pound to 30 square feet, one application being usually sufficient; or, if the soil contains considerable lime, superphosphate can be used at the rate of 10 ounces to 100 square feet, applied either in water (50 gallons) or sprinkled dry between the rows. If there is any doubt about the soil containing sufficient lime, give the plants a watering with freshly made lime water, 1 peck freshly slacked lime to 50 gallons of water for 200 square feet. This should be applied several days previous to the application of the superphosphate. Two or three applications of superphosphate at intervals of two or three weeks should be sufficient. As stated above, the greatest danger in violet growing is overfeeding. If the soil should be found too rich, treat as recommended for overfeeding of roses.

CARNATIONS.

SOILS.

The carnation especially requires a soil that drains rapidly and one permitting good aëration. The very light or very heavy types of soil should therefore be avoided. A good clay loam or sandy loam is desirable. For field use a good pasture sod with good drainage should be thoroughly manured, 30 to 40 cubic yards per acre, and plowed in the fall. Lime should be added at the rate of 1,000 pounds per acre in soils not already well supplied with this material. As soon as possible in the spring the land should be replowed and thoroughly harrowed till in a good friable condition. If the soil selected is a little light, besides a liberal coating of stable manure add 500 to 800 pounds of pure ground bone per acre or 500 pounds of superphosphate to the manure before the fall planting. If a sod soil is not obtainable, it will be best to sow a green manure crop—clover, cowpeas, or barley—to be turned under before seed forms. The leguminous crops will add considerable nitrogen as well as fiber to the soil, while such crops as barley add only fiber and humus. Special attention must be given to thoroughly incorporating the manure and decaying vegetable matter with the soil by repeated plowing or harrowing. Soil prepared as above should be rich enough to carry the plants through the summer up to the time they are to be moved to the houses. It is best to use the same type of soil for filling the beds as was used for field culture. The same preliminary preparation is advised as for field culture. After the spring plowing, however, the soil should be composted in a place convenient to the houses where it is to be used, 4 parts soil to 1 part well-rotted manure and 10 to 15 pounds of fine pure bone, free from common salt, to each cubic yard of compost. Many growers use much more bone than this (30 to 40 pounds per cubic yard), but it is safer to use the smaller amount and supply any lack later. The compost should, of course, be thoroughly worked over several times before use.

If the compost is made in the fall, one part manure to three parts soil can be used, and from 20 to 25 pounds of bone to the cubic yard. At the first turning of the compost 4 to 6 quarts of unleached wood ashes per cubic yard may be added if the soil is light, or if heavier use air-slaked lime at the same rate. After the plants are set in the house they will require no feeding till the roots have taken thorough possession of the new soil. Any feeding before this time will be likely to do harm and will do no good. Early feeding can be given, as in roses, by a light mulch of well-rotted manure. As the days grow shorter and colder, however, mulching should be discarded and liquid feeding used, as recommended for roses. Wagner's solution, mentioned under "Roses," is one of the best artificial combinations, furnishing nitrogen, phosphoric acid, and potash. It may be used about once in ten days or two weeks, as required, or it may be alternated with

liquid organic manures, as is the case with roses. The carnation is more sensitive even than the rose to overfeeding, especially during cloudy weather or semidormant periods or when the roots are not well developed. If the soil does become too rich, treat as in the case of overfed roses.

CARNATIONS IN COAL ASHES.

The Connecticut Agricultural Experiment Station has done some very suggestive and valuable work on growing carnations and other crops in sifted bituminous coal ashes[a] and 3 per cent of peat moss. This medium contains practically no plant food. All that the plants get has to be added in the form of fertilizers. One hundred square feet of bench space requires nitrate of soda, 3 pounds, 14 ounces; dissolved boneblack, 1 pound 1 ounce; muriate of potash, 1 pound 13 ounces. This should be thoroughly incorporated with the ashes before setting the plants. Under the conditions of the experiment this medium was found superior in some respects to rich compost made in the ordinary way. For a detailed discussion of this interesting experiment the reader is referred to the reports of the Connecticut experiment station.[a]

CHRYSANTHEMUMS.

The matter of fertilization of any crop does not resolve itself entirely into questions of the kind and amount of fertilizer used. This is particularly true of the chrysanthemum. Consideration must be given to the variety in hand and the character of the cutting. That a weak cutting or variety must receive different treatment from a hardy one should be self-evident.

The physical condition of the soil is of almost as much moment as its chemical constitution. It is of prime importance that the soil should be porous, in order that thorough drainage and aëration be obtained. For this purpose it is well to mix with the soil a certain amount of charcoal and sharp sand. The former is particularly desirable. The nature of the soil, too, governs the manner of potting. For a sturdy growth, light soil should be very firmly packed, while heavy soils require only loose packing.

COMPOSTS.

The consideration of the feeding of the chrysanthemum resolves itself into two parts, namely, the nature of the compost and of the subsequent feeding which takes place when the buds appear. It is commonly held that the basis of the compost should consist of a good fibrous loam. The use of a very heavy clay loam brings with it the danger of water-logged roots, while a very light sandy soil permits

[a] See reports of Connecticut Agricultural Experiment Station, 1896 to 1898, inclusive; also Proceedings American Carnation Society, 1899, page 30.

excessive leaching. It is preferable that one should err on the side of lightness rather than heaviness. With the loam, well-rotted stable manure may be mixed in various proportions, although the ratio of 1 part manure to 3 parts loam will probably give the best results. Horse, cow, and sheep manure all seem to be used with good results, but the cow manure is usually preferred.

It is often advantageous to add to the compost 1 part in 4 of good leaf mold. With the lighter soils this is particularly desirable, not so much because of any addition of nutrient substance, but because of its power of retaining water and nutrient substances.

Frequently various animal as well as mineral fertilizers have been added to the compost and sometimes even used as substitutes for the manure. Guano has thus been used with good results. A very good practice is to add to every cubic yard (20 bushels) of compost 40 pounds (4 pecks) of finely ground bone, which not only serves as a source of phosphoric acid and lime, but also furnishes some nitrogen. Soot also has with advantage been made a part of the compost. This furnishes as much as 3 per cent nitrogen, chiefly as ammonium sulphate, as well as small quantities of phosphoric acid and potash. It may be used at the rate of 1 to 5 pounds of soot to 100 pounds of the compost. Should the loam be at all deficient in lime, the lack should be corrected by the addition of a little ground oyster shell or a few handfuls of slaked lime, 2 or 3 pounds per cubic yard as a rule. A lack of lime will cause soft stems and flabby leaves.

Nitrate of soda and sulphate of ammonia have been recommended by some growers as a part of the compost. The evidence in favor of this practice is at present insufficient to commend it. It seems an unnecessary addition, with danger of a too concentrated soil solution and waste of nitrogen through rapid leaching. Excessive concentration of nutrients in the soil solution is more injurious than a deficiency, because of the inability of the roots to absorb solutions above a certain degree of concentration. The result is that the plant starves. Again, even though the concentration of the soil solution be not too great for absorption by the roots, in the presence of an excess of nutrients a good ball of roots is not produced; and, further, the roots are not in a condition to take up the subsequent liquid manure. The best plan is to have a moderately rich compost, thereby obtaining healthy roots, stems, and leaves, and then when buds appear, to apply the rich liquid manures. Experiment may show that the nitrate of soda and sulphate of ammonia may be used as a substitute for stable manure, although not as an addition to it. Still, this does not at present seem probable, the better plan being to reserve these for the subsequent feeding with liquid fertilizers.

LIQUID MANURES.

In general, it is not advisable to give the plant any additional food until the buds begin to appear. Then the plants, provided they have

good roots, may be fed and stimulated by the application of a number of liquid fertilizers. If at the time the buds begin to appear the root ball is a small one it will be advantageous to precede the use of liquid manure by giving the plants plenty of pure water, taking care, however, not to permit the soil to become water-logged. Of course the temperature and light conditions will in large measure govern the amount of water which can profitably be given. In the use of any kind of liquid fertilizer care must be taken not to begin with too strong a solution. It is far better to use a little less concentrated solution and to use it more frequently than to use an excessively strong liquid manure with long intervals between applications. It is important to remember that there should be no check in the growth.

Of the various liquid manures which have been used perhaps those obtained by soaking horse, sheep, or cow manure in water are the oldest. Such a manure water may be made by soaking a peck of manure in 50 gallons of water for three days, or a bushel may be allowed to soak in 50 gallons of water for a few days, and then, when needed for use, the solution may be diluted seven or eight times. This latter method is the more convenient one. Guano manure water may be made in the same way. Such a liquid manure is given once a week from the time the buds make their appearance until the flowers are about three-quarters expanded.

Although good results have been obtained with the above, rather better results are reported from the use of some of the mineral nitrogenous fertilizers. Both the nitrate of soda and sulphate of ammonia give good results, although the latter is preferred. Ammonium sulphate may be given once a week at the rate of 6 to 8 ounces to 50 gallons of pure water, or it may be added to liquid stable manure in the same ratio or in the proportion of 1 ounce to 50 gallons of the manure water. By some growers a strong solution is employed, 1 ounce of sulphate being dissolved in 4 gallons of water. Nitrate of soda has been used in like ratio, but in its use there is danger of flabby petals.

While the flowers need an abundant supply of nitrogen, they nevertheless require other elements in considerable amounts. The objection to either of the above-mentioned mineral fertilizers is that they provide for only one of the important needs of the flower. A balanced liquid manure is necessary. Wagner's solution, which has been recommended for the rose, gives excellent results with the chrysanthemum. The only objection which may be urged against it is that it probably is too weak. In view of its balanced character, the total concentration could probably be slightly increased with profit.

EFFECT OF THE VARIOUS FOODS.

The chrysanthemum is a strong nitrogen feeder, but an excess of this element is possible, and the effect is to be seen in the soft character of stem, leaves, and petals. In addition to a large nitrogen

requirement the chrysanthemum needs considerable amounts of potash and phosphoric acid, and, to a lesser degree, of lime. The question of the best sources of potash and phosphoric acid is one still largely to be determined. As a source for potash, muriate of potash, sulphate of potash, and wood ashes have been used with satisfactory results, although the first mentioned seems to give the best results. Fine ground bone has been chiefly used as a source of phosphoric acid, not alone because of its available condition, but also because it serves as a source of lime and of a certain amount of nitrogen.

Among the various nitrogen compounds used as liquid fertilizer the sulphate of ammonia is the best. When applied in just the right quantity, which botanists call the optimum amount, it is of particular value in producing rich green foliage and for heightening and clearing the color of the petals. In fact, for this latter purpose the nitrogenous mineral fertilizers are preferable. In the "Glory of the Pacific," the white color of the petals may be made perfect by the use of nitrate of soda and sulphate of ammonia. An excess of ammonium sulphate or nitrate of soda produces a too rapid growth, soft stem, and flabby petals. Red and other dark forms are especially sensitive to an excess of nitrogen; they are very apt to burn. With such varieties the use of liquid fertilizers should cease as soon as the buds are well formed and of good size. Even for the lighter-colored forms, a liquid fertilizer should not be continued too long; applications should stop when the flowers are about three-quarters expanded.

While quite a little lime should be present in the soil, still there is a limit. Over 7 pounds of lime to the cubic yard is an excess. The result is a stunted, brittle type of growth. Increasing the amount of muriate of potash which may be in the soil partly counteracts the injurious action of the lime; that is, when the amount of lime is not much over 7 pounds per cubic yard.

Too much watering is to be avoided, because of the danger of leaching. Heavy watering often causes the leaves to become pale green and flabby. According to a number of growers, such a condition may be corrected by allowing the plants to remain fairly dry for a few days and then soaking the roots in a solution of sulphate of iron at the rate of one-half ounce to 1 gallon of water. This method causes a speedy return of the green color and healthy condition of the leaves.

Very hot and very dull days are to be avoided when applying liquid manure. In the former case the plant absorbs the nutrient salts faster than it can use them, while on a dull day the absorption is too slow, and there is danger of suffocation of the roots.

Most crops have specific food requirements. While the chrysanthemum may, for example, require rather more nitrogen than the average, it does not follow that its need of other nutritive elements is insignificant. It is true that in some cases an excess of one nutritive

element may in part counteract some deficiency of another; the counteraction is, however, only partial. An amount of nitrogen food which, in the presence of minimum quantities of potash and phosphoric acid, is excessive, may prove to be the optimum amount when the quantity of available potash and phosphoric acid is increased up to a certain point. In the fertilization of chrysanthemums, as in any other plant, the most important consideration is not the actual quantity of any food element offered; that is of secondary importance. *What is of prime importance is the ratio of the various food elements in available condition.* The amount of any food which can or should be given the chrysanthemum or any plant is very largely governed by the proportion in which the various elements are offered.

Of course, the problem is to get the largest return for the least outlay. A plant may be able to take up large amounts of fertilizer and yet give no better return than when the food supply is less. So the question is one of the smallest amount of available fertilizer which will give the greatest return. Experiment indicates that a chrysanthemum soil containing one-third rich cow manure should have added to it in subsequent feeding a complete fertilizer containing from 5 to 6 per cent of nitrogen, 6 to 7 per cent of phosphoric acid, and 3 to 4 per cent of potash, all in available condition, and at the rate of about 3 ounces per cubic foot of soil for each feeding.

TOMATOES.

According to many growers the character of the soil for forcing house tomatoes is not a matter of great importance. It is necessary that there be good drainage, but both light and heavy soils have been used with good results. Nevertheless, those who get probably the best results commonly use a light sandy loam. Very good results have also been obtained with a soil composed of coal ashes, with 5 per cent of peat moss, to which various fertilizers have been added. The kind, quantity, and method of use of manures and fertilizers are questions of importance.

A compost—one used for many crops—consisting of 3 parts light sandy loam and 1 part well-rotted horse manure, serves very well for tomatoes. The proportion of manure in the soil has been considerably varied, but the results as published do not appear to differ in proportion to the variability of the compost. In addition to manure, tankage is often added to the compost at the rate of 100 pounds to every 5 cubic yards of compost. When good manure is not available for the compost a good soil may be obtained, according to Voorhees, by adding to every hundred square feet of bench the following mineral fertilizers: Nitrate of soda, one-half pound; acid phosphate, 1 pound; muriate of potash, one-half pound. This holds good until the fruit begins to form, when it is well to give one-fourth pound nitrate of soda every week, and every two weeks 1 pound acid phosphate

and 1 pound muriate of potash. These may be applied in solution or dusted as a powder between the plants and well worked in before watering. Jenkins and Britton, of the Connecticut experiment station, have obtained highly satisfactory results by using a mixture of coal ashes and peat mixed with various fertilizers. This method has been productive of a yield of 2 or more pounds of fruit per square foot of bench surface. By such methods it has been shown that the vine and fruit of single-stem plants can take up the following ingredients per hundred square feet of bench: Nitrogen, 168 grams, equivalent to nitrate of soda, 2 pounds 5 ounces; phosphoric acid, 65 grams, equivalent to boneblack, 13 ounces; potash, 362 grams, equivalent to muriate of potash, 1 pound 9 ounces. Of this amount nearly four-fifths went into the fruit. Analyses show that each 100 pounds of tomatoes removed from the soil: Nitrogen, $2\frac{1}{3}$ ounces, equivalent to nitrate of soda, 14 ounces; phosphoric acid, $\frac{9}{10}$ ounce, equivalent to boneblack, 5 ounces; potash, $4\frac{2}{3}$ ounces, equivalent to muriate of potash, 10 ounces.

It is estimated that in the case of tomatoes grown on ordinary compost the relation between the fertilizer taken from the soil by the fruit and vine is rather different from that given above for coal ashes and peat. In the case of compost plants about half of the fertilizer removed by the plant is found in the fruit. Hence, if the vine and roots be returned to the soil a very considerable part of the fertilizer applied may be recovered.

It is, however, well known that a large part of the manure offered is not taken up by the tomato. The estimate is that not more than from one-half to two-thirds of the fertilizer furnished is taken up by the plant. According to Lawes and Gilbert, only 40 per cent of the fertilizer furnished is taken up during the first year. Accordingly, more fertilizer must be added to the soil than the plant actually removes, as shown above. Light is another factor to be considered in applying fertilizers. During the darker months of the season metabolic activity is at a considerably lower ebb than during the brighter months (February to July), and hence during this brighter period more fertilizer can be absorbed by the plant, and the assimilation is more active. During such a bright season Jenkins and Britton have found that the tomato will take up the following amounts per hundred square feet of bench: Nitrogen, 226 grams, equivalent to nitrate of soda, 3 pounds 10 ounces; phosphoric acid, 74 grams, equivalent to boneblack, 1 pound; potash, 391 grams, equivalent to muriate of potash, 1 pound 12 ounces. Of this amount less than two-thirds was contained in the fruit.

It seems that there is but little danger of overfeeding the tomato. Still, while abundant fertilizer may not be injurious to the crop, there is a point beyond which fertilization is needless; that is, feeding up to a certain point produces a larger and better crop, but beyond this,

although the plant may take up all that is offered without diminishing the yield of fruit or even injuring its quality, it is manifest that feeding above this optimum point is waste. So the mere fact that the plant will take up a certain amount of fertilizer is not in itself sufficient evidence that that amount of fertilizer is required. Of course, there is a point to go beyond which is not only waste but will result in injury to the crop.

The following formula per hundred square feet of bench in a soil of ashes and peat has been found not only to diminish the yield of fruit but likewise to produce an inferior quality: Nitrogen, 28 ounces, equivalent to nitrate of soda, 6 pounds 8 ounces, or cotton-seed meal, 11 pounds 2 ounces; phosphoric acid, 6 ounces, equivalent to boneblack, 2 pounds 1 ounce; potash, 24 ounces, equivalent to muriate of potash, 3 pounds 4 ounces.

In addition to using very rich composts, some pursue the practice of giving liquid manure frequently during the growing period. Others give the liquid fertilizer only during the formation and ripening of the fruit, and this latter method is favored by the experimental evidence. As liquid fertilizer, one may employ solutions of stable manure or of commercial fertilizers. When liquid mineral fertilizers are used, that suggested by Voorhees, previously mentioned, is to be recommended.

A word may be said concerning the food needs of the various plant parts and the advantages of the several forms in which nitrogen, phosphoric acid, and potash may be furnished. Analyses show that all parts of the plant take up far more potash than nitrogen or phosphoric acid. This is least marked in the roots, and most evident in the fruit, where the potash is nearly double that of the nitrogen, and nearly five times that of the phosphoric acid. Accordingly, it is important that potash predominate in the manures. There is also the further reason for a very liberal supply of potash in that nitrogen can exert its fullest action only in the presence of rather more than the minimum amount of potash and phosphoric acid required by the plant. Potash is commonly furnished in the form of muriate, although the carbonate and sulphate also give good results. Wood ashes constitute a good source of potash, and have the advantage of not only correcting soil acidity, but likewise furnish carbonate of lime, which the tomato requires in the ratio of 25 pounds for every 800 cubic yards. Wood ashes may be applied at the rate of 20 pounds to every 50 cubic feet.

As sources of nitrogen in the organic condition, besides stable manure, the following may be applied: Cotton-seed meal, guano, castor pomace, and spent mushroom spawn. A too crude manure causes a very rank growth. By many, nitrate of soda is considered the best source of quickly available nitrogen for the tomato; in fact, it is looked upon by many as a specific for this plant. The sulphate of

ammonia has not yielded quite so good results. One advantage of nitrate of soda is that it can be used up to the last, for instead of retarding the maturity of the fruit it hastens it.

Phosphoric acid is required in considerably smaller quantity than either nitrogen or potash. It is, however, a mistake to overlook it in making up the compost or liquid manure. Like potash, it is also important in order to secure the fullest action of nitrogen. A very slight deficiency in phosphoric acid will cause a considerable retardation in the maturing of the fruit. Dissolved boneblack is probably the best source of phosphoric acid, although finely ground bone gives excellent results. An advantage in using bone is that it serves as a convenient source of lime as well as phosphoric acid. However, too much lime produces excessive stem and leaf development, and a diminished yield of fruit. It is well to note that watery fruits are richer in ash content than are the more fleshy ones.

In order to secure the largest yield of good fruit, the following is recommended: Nitrate of soda, $6\frac{2}{5}$ pounds; boneblack, 1 pound; muriate of potash, $2\frac{2}{5}$ pounds. This should be added to 75 cubic feet of a soil consisting of coal ashes (anthracite or bituminous) and 5 per cent of peat moss. In case ordinary loam be used in place of the coal ashes and peat, the following may be recommended for every 100 cubic yards of good loam: Well rotted manure, 240 pounds; dissolved boneblack, 13 pounds; muriate of potash, 25 pounds.

LETTUCE.

For forcing house lettuce the physical condition of the soil is fully as important as for the chrysanthemum. Experiments have been made with a great variety of soils, but a light or medium clay loam appears to give the best results. It is important that the soil should be of such a nature as to offer but little resistance to the passage of roots through it. Jenkins and Britton have employed a soil consisting of coal ashes and peat, to which various fertilizers have been added. This has not been as productive of good results as was the case for tomatoes, possibly because of the resistance which the ashes offered to root growth. The very general compost of 3 parts medium clay loam and 1 part well-rotted manure has also been used for lettuce, although the proportion of manure should doubtless be much increased, or certain mineral fertilizers should be added to the compost.

Experiments dealing with fertilizers for lettuce have yielded some apparently very conflicting results. One set of results indicates stable manure as the best kind of fertilizer, while another shows good results when only mineral fertilizers have been used. A careful study of the reports suggests, however, that the conflict is probably one of interpretation.

As sources of potash, the muriate and the sulphate of potash, the carbonate of potash and magnesia, and wood ashes have been used.

The sulphate seems to give best results. Concernin
general opinion is that it is distinctly injurious. Stu
when he added muriate alone, or with nitrate of soda
1,026 pounds of muriate and 1,503 pounds of nitra
obtained smaller plants than from the unfertilized che
is not, however, to be considered as showing the inju
the muriate, but is rather indicative of the unbalanc
this fertilizer. For when to this same amount of pota
fertilizer, boneblack at the rate of 1,503 pounds per a
luxuriant and abundant growth is obtained.

Phosphoric acid seems to be furnished with equal b
the form of boneblack or of dissolved rock phosphate
however, preferred.

Experiments with nitrogenous fertilizers have led t
results. By some, nitrate of soda and sulphate of am
ferred, while many others give the farmyard manures
In a recent report, Beach and Hasselbring advocate th
sources of nitrogen, since in the aggregate they obtai
better yields with barnyard manure or dried blood
mineral nitrogenous fertilizers. Because better result
in all cases when from 5 to 20 per cent of manure was
tion to the commercial fertilizer, they concluded that
only advantageous but necessary. The conclusion is
well founded. To begin with, the amount of mineral
to the loam was very small. Again, there is no record
ment in which the amount of mineral fertilizer was in
respond to the addition of manure. Only by mea
experiment could the relative value of organic and in
of nitrogen be determined. The results of Stuart wi
tilizers show that such may be used with advantag
fertilizer is given in sufficient quantity and the elem
proper ratio to each other.

The formula used by Stuart with such good results
mended for lettuce. To a good loam the following in
added to every acre of soil (6 inches deep): Nitrate
pounds; dissolved boneblack, 1,503 pounds; muriate

FERTILIZERS FOR SPECIAL CROPS.

COMPOSITION OF FERTILIZERS.

For convenient reference, the following tables, showi
sition of barnyard manures and commercial fertilizers, a

Analyses and value per ton of manure of different ani

[From Farmers' Bulletin No. 21.]

Manure.	Water.	Nitrogen.	Phosphoric acid.
	Per cent.	*Per cent.*	*Per cent.*
Sheep	59.52	0.768	0.391
Calf	77.73	.497	.172
Pig	74.13	.840	.390
Cow	75.25	.426	.290
Horse	48.69	.490	.260
Hen	56.00	0.80 to 2.000	0.50 to 2.000

Composition of dry matter in solid and liquid manu

[From Farmers' Bulletin No. 21.]

Manure.	Nitrogen.		Phosphoric acid.	
	Solid.	Liquid.	Solid.	Liquid.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Horse	2.08	10.9	1.45	Trace.
Cow	1.87	10.0	1.56	Trace.
Swine	3.00	12.0	2.25	5.00
Sheep	1.78	10.4	1.42	.37

Composition of the principal commercial fertilizing m

[From Farmers' Bulletin No. 44.]

Constituent.	Nitrogen.	Available phosphoric acid.	Insoluble phosphoric acid.	Total phosphoric acid.
1. Supplying nitrogen:	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Nitrate of soda	15.5 to 16.0			
Sulphate of ammonia	19.0 to 20.5			

Composition of the principal commercial fertilizing materials—Continued.

Constituent.	Nitrogen.	Available phosphoric acid.	Insoluble phosphoric acid.	Total phosphoric acid.	Potash.	Chlorin.
2. Supplying phosphoric acid—Continued.						
	Per cent.	*Percent.*	*Percent.*	*Per cent.*	*Per cent.*	*Per cent.*
Florida superphosphate (dissolved Florida phosphate)		14 to 16	1 to 4	16.0 to 20.0		
Boneblack			32 to 36	32.0 to 36.0		
Boneblack superphosphate (dissolved boneblack)		15 to 17	1 to 2	17.0 to 18.0		
Ground bone	2.5 to 4.5	5 to 8	15 to 17	20.0 to 25.0		
Steamed bone	1.5 to 2.5	6 to 9	16 to 20	22.0 to 29.0		
Dissolved bone	2.0 to 3.0	13 to 15	2 to 3	15.0 to 17.0		
Thomas slag				[a]11.4 to 23.0		
3. Supplying potash:						
Muriate of potash					50.0	45.0 to 48.0
Sulphate of potash (high grade)					48 to 52.0	0.5 to 1.5
Sulphate of potash and magnesia					26 to 30.0	1.5 to 2.5
Kainit					12 to 12.5	30.0 to 32.0
Sylvinit					16 to 20.0	42.0 to 46.0
Cotton-hull ashes[b]				7.0 to 9.0	20 to 30.0	
Wood ashes (unleached)[b]				1.0 to 2.0	2 to 8.0	
Wood ashes (leached)[b]				1.0 to 1.5	1 to 2.0	
Tobacco stems	2.0 to 3.0			3.0 to 5.0	5 to 8.0	

[a] In good Thomas slag at least 80 per cent of the phosphoric acid should be soluble in ammonium citrate, that is, available.

[b] Cotton-hull ashes contain about 10 per cent of lime, unleached wood ashes 30 to 35 per cent, and leached wood ashes 35 to 40 per cent.

CROPS USED IN THE RECLAMATION OF ALKALI LANDS IN EGYPT.[a]

By THOMAS H. KEARNEY, *of the Bureau of Plant Industry*, and THOMAS H. MEANS, *of the Bureau of Soils.*

INTRODUCTION.

Important projects are now on foot which will lead to a great increase in the area of land under irrigation in the arid part of the United States. But every extension of irrigation is sure to be followed by a "rise of alkali" in the lower levels of the land thus opened to agriculture unless drainage is properly looked after. Hence, the time is opportune for calling attention once more to the "alkali" problem and to ways in which it can be met.

In parts of Egypt, with its hot, arid climate, and its extensive irrigation system, there are great stretches of land that have become too salty to produce crops. There, too, the vexing question of how to deal with alkali[b] calls for an answer. Systematic efforts to wash these lands and restore to them their former fertility are being made on a large scale in Egypt, both by the Government and by private capital. It will be interesting to consider the methods used in this work with a view to applying them as far as possible in the reclamation of alkali lands in the United States. But, as conditions in Egypt are in many respects peculiar, a knowledge must first be had of the climate, soils, and agriculture of that country.

CLIMATE.

The climate of Egypt is arid. Over the greater part of the country there is practically no rainfall, and in no part is there enough to produce crops without irrigation. The temperature is uniformly high. Light frosts occur in the winter, but the growing of citrus fruits is possible throughout the country. That part of the country in the narrow valley south of Cairo has a true desert climate, that is, a very dry atmosphere, with hot days and cloudless skies. Lower Egypt, or the Delta of the Nile, receives the moisture-laden winds from off the Mediterranean, so that the climate differs greatly from that of the

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[a] The observations upon which this paper is based were made in the course of a visit to northern Africa under the auspices of the Office of Seed and Plant Introduction and Distribution, Bureau of Plant Industry. The primary object of this expedition by Messrs. Kearney and Means was to secure seeds of plants suitable for introduction into the arid parts of the United States.

[b] The word "alkali" is used in this paper in its popular sense, as applying to excessive accumulations in the soil of soluble salts of any kind, and not in its strict chemical meaning.

desert. At points near the coast the air is moist, while at Cairo, at the apex of the Delta, the influence of the surrounding desert is felt and the air is much drier. In the United States, the region from San Antonio, Tex., to Montgomery, Ala., has a summer climate very similar to that of Lower Egypt. The climate of southern Arizona and southeastern California closely approximates that of Upper Egypt. Both are very dry and hot, but the extremes of cold are greater in our American deserts.

IRRIGATION.

The agricultural lands of Egypt lie entirely within the narrow Valley of the Nile, extending from the first cataract to the Mediterranean, a distance of 700 miles. At Cairo the valley widens into a broad, fan-shaped delta with a level surface, sloping gently toward the sea. On the west side of the Nile Valley, 60 miles south of Cairo, there is a break in the desert hills, and through this depression the Nile water is carried into a valley which forms the province of Fayum.

All of the soils of Egypt are alluvial in origin and have been derived directly from the deposition of mud by the Nile. The Nile rises in Central Africa, in a region of great rainfall, and flows northward across the Sahara Desert. The level of the water in the river is at its lowest stage during May and the early part of June. About the middle of June the annual rise commences and continues until the middle of September. This rise amounts to about 35 feet on the average, and the maximum height is maintained for from four to six weeks, when the water commences to fall, reaching its minimum again in May.

Under the ancient system of irrigation, which has been practiced in Egypt for thousands of years, water from the river at the season of flood is turned into basins (Pl. LXXVIII, fig. 1) which vary in area from 500 to 50,000 acres. Each of these basins is filled with water to a depth of from 3 to 5 feet, and at the end of six weeks the excess water is drained back into the Nile. Crops are then sown upon the mud without previous cultivation. Under this system of irrigation generally but one crop a year is possible.

During the early part of the last century a movement was started which has revolutionized irrigation methods in Egypt. Deep canals were dug so that water could be taken from the Nile at the season of low water, thus permitting irrigation throughout the year. This system of irrigation, which is the one in common use in the western portion of the United States, is known in Egypt as perennial irrigation, and by its use two and sometimes three crops can be grown in a a year. The lands lying immediately along the banks of the Nile are higher than the lands farther away from the stream, so that it is frequently necessary to lift the water up to them by artificial means. To accomplish this there are in use a number of simple water-lifting machines, worked by hand or by animal power. The simplest of

FIG. 1.—BASIN IRRIGATION IN EGYPT.

[The bank between the two basins is used as a road.]

FIG. 2.—ROCKER FOR LIFTING WATER SHORT DISTANCES.

[One of the many simple devices for irrigation in use in Egypt.]

FIG. 1.—THE NILE RESERVOIR DAM AT ASSUAN.

FIG. 2.—THE ASSIUT BARRAGE ACROSS THE NILE.

[The increase in crop values from the use of this barrage the first year exceeded its cost—$4,250,000.]

these is the "shaduf," which consists of a goatskin bucket on the end of a sweep, the other end of which is weighted with a ball of dried mud. Fig. 47 shows the construction and method of operating one of these shadufs. Another method of lifting water in common use is the "sakkia," which consists of buckets on a rope or chain, lifted by animal power. A number of other simple instruments are in use (Pl. LXXVIII, fig. 2). Among these might be mentioned the Archimedes screw, used for short lifts, and in some cases even a basket, suspended by four ropes and swung by two men, is used for lifting water out of a ditch onto the land immediately adjoining.

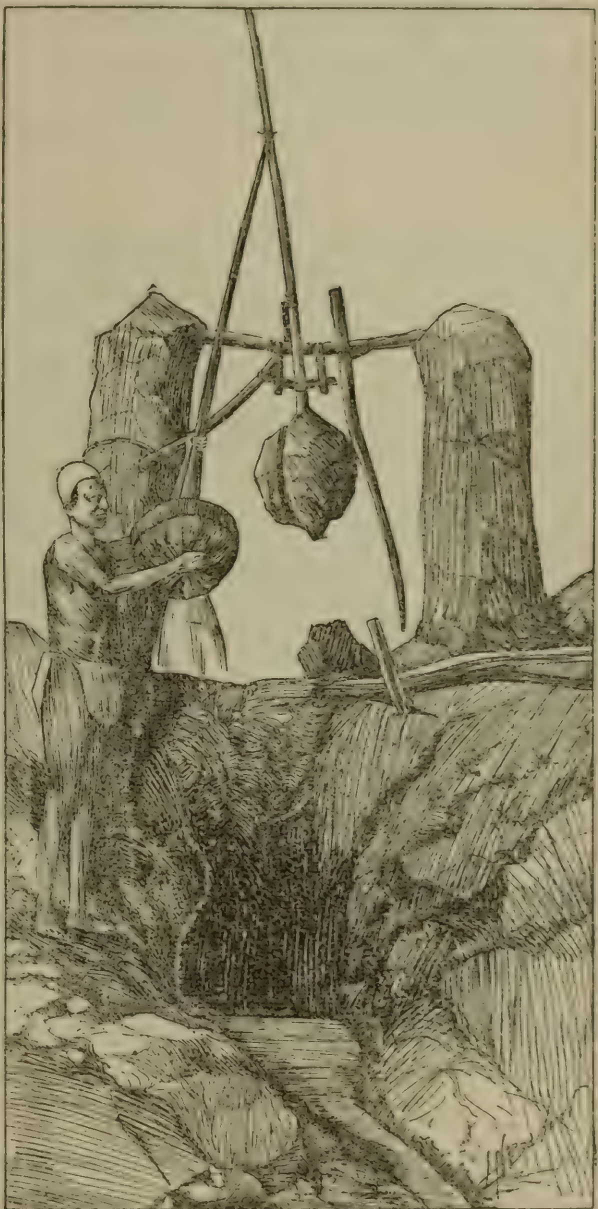

FIG. 47.—Shaduf, used in lifting water along the Nile and large irrigating canals in Egypt, with which water can be lifted 6 or 8 feet.

In striking contrast with these simple and crude methods of irrigation are the massive engineering works recently constructed, or now under construction, by the Government. In the conversion of lands from basin to perennial irrigation it has been necessary to maintain a more uniform supply of water than is ordinarily given by the Nile. The minimum flow of the river is estimated at 8,000 cubic feet per second, while for all the land now under perennial irrigation 20,000 cubic feet per second should be supplied. In order to insure this 20,000 cubic feet per second throughout the season of low water, it has been necessary to conserve a portion of the flood water by the construction of a large dam near Assuan, at the first cataract. This dam is shown in Pl. LXXIX, fig. 1. The dam is $1\frac{1}{4}$ miles long, and has a height above the gate sills of 70 feet. The reservoir created by this dam stores about 800,000 acre-feet of water, or sufficient to permit of the conversion of about 600,000 acres of land from basin to perennial irrigation. Supplementary to this dam there have been planned a

number of barrages, or diversion dams, at points along the Nile at the heads of the main canals. Of these diversion dams, two have now been constructed, one at Assiut (Pl. LXXIX, fig. 2), which raises the level of water in the river sufficiently to permit of water being taken out during the low season and which feeds the important canals of Upper Egypt, and one at the point where the Nile divides, at the head of the Delta, about 12 miles from Cairo. This barrage consists of two dams thrown across the two arms of the Nile, and raises the level of the water to such a height that the canals which supply Lower Egypt, or the Delta of the Nile, can be kept full of water throughout the season.

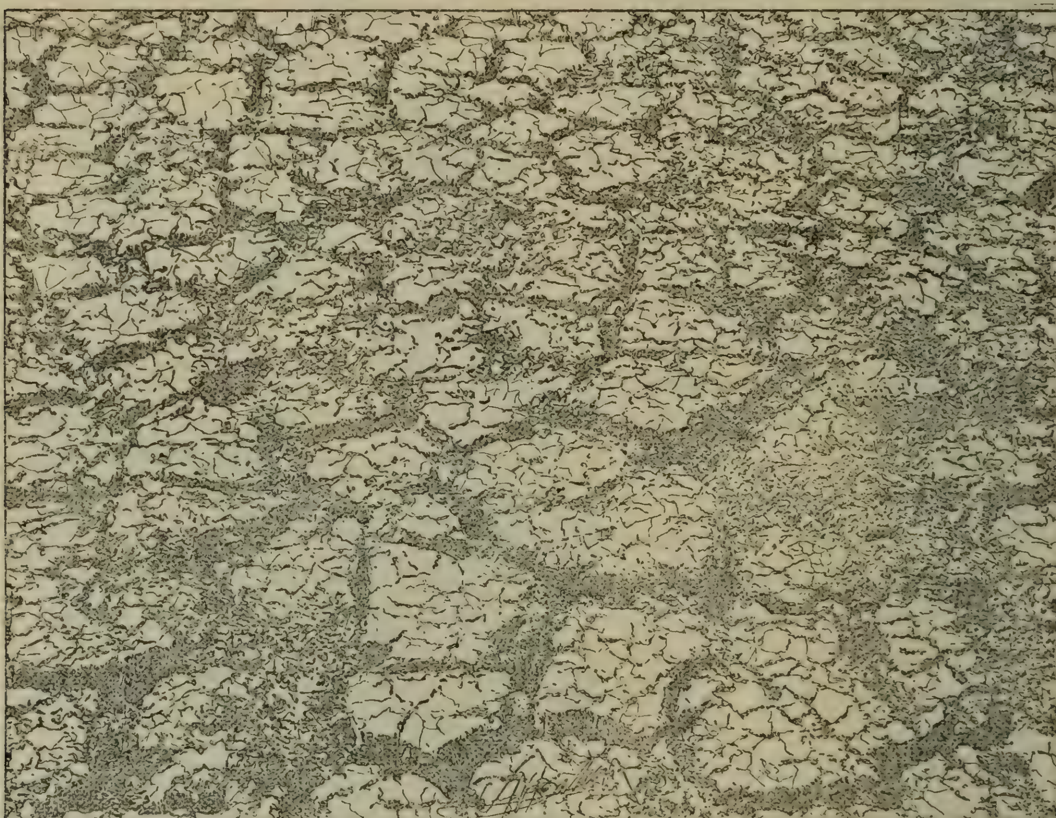

FIG. 48.—Surface of black-clay soil deposited by the Nile, Egypt. Soil cracked like sample shown is considered free from a harmful quantity of alkali.

By these irrigation works, which have been constructed on the most approved plans and at great expense, all of the land of Lower Egypt is now farmed under perennial irrigation, and a considerable percentage of the land of Upper Egypt receives water throughout the year. By these systems the crop-producing capacity of the country has been more than doubled.

SOILS.

The soils of Egypt are alluvial in origin. The typical soil is a heavy, black, sticky clay, which bakes and cracks (fig. 48) as does the bottom of a mill pond when exposed. This soil is difficult to work, but is exceedingly fertile, and its fertility is maintained by the mud

deposited by the irrigation waters. The practice of applying commercial fertilizers is gradually becoming general, as it is found that the increase in crop produced by the application of manure more than pays for the cost of manuring.

CROPS GROWN.

Egypt is peculiar among the countries of the world in its agriculture as in other things. It is a one-river country; from the standpoint of agriculture the narrow Valley and the broad Delta of the Nile are almost the whole of Egypt. Agriculture is the life of the country; more so, perhaps, than anywhere else in the world. Agriculture is highly developed, and intensive methods are used in cultivating several of the most important crops. This is rendered possible by the abundance of cheap farm labor. In 1898 it was estimated that there were in Egypt 5,750,000 acres of land either in actual cultivation or in process of reclamation by washing and drainage. Of this, 2,320,000 acres is in Upper Egypt and 3,430,000 in Lower Egypt. The renting value of land in all Egypt was estimated at $106,700,000, representing 57 per cent of the gross yield of the land.

The Egyptian agricultural year is divided into three seasons, that is, the summer, from April 1 to August 1; the flood, from August 1 to December 1; and the winter, from December 1 to April 1. These seasons, of course, overlap to some extent, the summer crops being still in the land when the flood crops are sown. Cotton, sugar cane, maize, sorghum, and rice are among the principal summer crops; sorghum, maize, and rice are also grown as flood crops; clover, wheat, barley, and beans are winter crops.

Upper Egypt differs from the country north of Cairo in the fact that the "basin system" of irrigation (Pl. LXXVIII, fig. 1) is still widely practiced. Of the 2,300,000 acres of irrigated land in Upper Egypt, 1,435,000 is still basin land, and is farmed by methods that have come down with practically no change from the time of the Pharaohs. Of the remainder, two-thirds is subject to perennial irrigation and one-third to irrigation in flood time only. About 2,120,000 acres in Upper Egypt produce winter crops, 370,000 acres summer crops, and 530,000 acres flood crops. The average value per acre of the year's crops in Upper Egypt is estimated by Mr. Willcocks at about $33.50.

The principal winter crops are wheat, beans, clover, barley, and lentils, in large part sown on the basin lands after the flood water has been drawn off, but also extensively grown on the perennially irrigated land. Of summer crops, the most important are cotton, sugar cane, sorghum, garden vegetables, and melons. Of these, sugar cane and cotton are limited to the perennially irrigated lands, while the chief summer crops of the basins are sorghum, millet, and cucumbers. These summer crops are grown only in the lowest part of the basins,

where enough soil moisture remains from the preceding flood to produce a crop without irrigation or rainfall. Indian corn, sorghum, and millet are the main flood crops of Upper Egypt, but are, of course, not grown in the basins, which are full of water during high Nile.

Conditions somewhat different from those of the Nile Valley proper are presented by the oasis province of Fayum, where all the cultivated land receives a perennial supply of water from the Bahr Yusuf Canal. Here all of the principal crops of Upper Egypt except sugar cane are extensively grown on the well-drained lands, while rice and "samar" are grown in some quantity in low lands. In addition, olives, figs, grapes, and other fruits are produced, and there are great numbers of date palms, often of excellent varieties. The Fayum, together with the part of the Nile Valley that lies between Cairo and Beni Suef, produces the great bulk of the date crop of Egypt.

From Lower Egypt the basin system has practically disappeared, and all land of any considerable value is irrigated by the perennial method. About 2,140,000 acres in this part of the country is planted to winter crops, 1,670,000 to summer crops, and 980,000 to flood crops, the same land in many cases producing a winter crop and a summer or a flood crop in the same year; hence winter crops cover 60 per cent, summer crops 50 per cent, and flood crops 30 per cent of the total cultivated area. Mr. Willcocks computes the average total value of the year's crops from an acre of land in Lower Egypt to be about $34.50 and the net mean profit at $20 to $22.50.

The more important winter crops are the same as in Upper Egypt, while in addition the growing of early garden vegetables—onions, potatoes, tomatoes, etc.—for the European markets is becoming an important industry, particularly near the coast. Bananas, oranges, and other tropical or subtropical fruits are also produced. The chief summer crops are cotton, maize, sorghum, Sultani rice, various garden vegetables, and a limited amount of sugar cane. Of flood crops, maize and Sabeini rice occupy the largest area and furnish a large part of the food of the agricultural classes.

The great staple of Egypt to-day is cotton, although hardly eighty years have passed since its cultivation was first introduced. So remunerative is this crop that almost the whole agriculture of Egypt is subordinated to it, and is necessarily one-sided. Land that will bring a good crop of good cotton can rarely be used to better advantage in other ways. The estimated area in cotton in 1897 was 1,200,000 acres, the annual production aggregating 550 million pounds. The average yield of fiber per acre for the whole country is computed to reach the remarkably high figure of 460 pounds; while on an acre of average good land 500 to 600 pounds of fiber are obtained, and from very good lands in one or two provinces 700 to 800 pounds can be expected.

Maize and sorghum are leading crops in all parts of Egypt, affording

a large part of the food of the "fellaheen," or peasantry. Rice, extensively grown in the low lands of the Delta, is likewise a very important article of diet in Egypt. Sugar cane is the chief staple in much of Upper Egypt.

Of winter crops, berseem, or Egyptian clover, in rotation with cotton and other crops, is of immense value as a restorer of nitrogen to the soil and as a forage plant. It is vastly more important than alfalfa in Egypt. Hard wheats, barley, and broad beans are also extensively grown in all parts of Egypt.

ALKALI.

More than a thousand years ago, at the time of the Arabian conquest of Egypt, large areas of land lying close to the Mediterranean and only a few feet above sea level were devastated and allowed to lie idle. Portions of this land are to-day covered with sea water at high tide, and other portions have been subject to evaporation for long periods of time. The result has been that there are now large areas containing an excess of salt and alkali which at the present time are out of cultivation. In Upper Egypt other areas have been allowed to lie idle for shorter periods—forty or fifty years—and the result there has been that alkali has risen to the surface. The change in the method of irrigation has had something to do with this, for where land is flooded for only six weeks, as was formerly the practice throughout the country, the water removes most of the salt, or else washes it down so deep that it can not readily return to the surface.

RECLAMATION OF ALKALI LANDS.

There has probably been more work done in the reclamation of alkali and salt lands in Egypt than in any other country. It is estimated that fully half a million acres of land more or less charged with alkali salts have been brought back into cultivation, and that there are still over a million acres unreclaimed. Extensive operations are now being carried on for the reclamation of this land. As the subject is becoming one of great importance in the United States, a description of the methods in use in Egypt should be valuable to the farmers of arid America.

The methods in actual use are varied to suit the local conditions, but in general it can be said that the method consists of dividing the land into small tracts of about 3 acres by drainage ditches, dug to a depth of 2½ or 3 feet, and flooding each of these tracts until the salt is removed through the drains. The drains are usually 150 feet apart, though in the lighter soils and those containing a small percentage of salt the distance is increased to 300 feet.

The cost of reclamation is variously estimated at from \$15 to \$30 per acre, and it is thought that the average is not far from \$20. To thoroughly reclaim the land, washing is carried on for from one to

four years, depending upon the nature of the soil and the ease with which the salt is washed away. In many places, however, this time is not lost, but crops of value are grown while the washing is going on. As during much of this time the land is flooded to a depth of at least 4 inches, it is necessary to grow such crops as will live with their roots in standing water. The most important crops at present in use in Egypt are rice (Pl. LXXX, fig. 1), barnyard grass (Pl. LXXXI, fig. 2), and a reed called "samar" (Pl. LXXXI, fig. 1).

At the end of the period of preliminary washing, during which these crops are grown, Egyptian clover and cotton are planted. In rotation with these crops occur further periods of washing, either without crops or with rice, barnyard grass, or samar. By this method of flooding and washing in alternation with ordinary cultivation, the alkali salts which rise during the season when flooding is intermitted are washed out into the drains and entirely removed. As soon as the salt has been washed down to the level of the bottom of the drains it is no longer necessary to flood the land during part of the year, but ordinary crops, varied according to the judgment of the individual farmer, are grown.

CROPS USED IN THE PROCESS OF RECLAMATION.

Three plants are especially popular in Egypt for this purpose—barnyard grass, rice, and samar. All of these have one useful quality in common: They will thrive in the presence of great quantities of water; consequently the work of washing the land can go on unhindered while the crop is standing. There is considerable difference of opinion in Egypt as to which of these plants is most resistant to alkali, but other conditions generally determine which shall be used in a given area.

BARNYARD GRASS, OR DINEBA.

Barnyard grass (*Panicum crus galli*), generally known in Egypt as "dineba," is the crop most extensively used, and is probably the most generally useful. (Pl. LXXXI, fig. 2.) Its use is widespread in the northern part of the Delta, near the Mediterranean coast. In order to give some idea of the part played by this plant in reclaiming salt lands, its use by the Abukir Land Company, near Alexandria, will be described.

This land, in its unreclaimed state, presents an almost perfectly level expanse (the bed of the ancient Lake Abukir), with a rather sandy soil, containing sometimes as high as 10 per cent of common salt, strewn with sea shells, and entirely devoid of vegetation. The drainage ditches and subsidiary irrigation canals having been constructed, the land is flooded to a depth of 4 inches, and is kept flooded for six months, if possible, commencing in autumn. Almost immediately after the digging of drainage ditches the accomplishment of the first stage in the "sweetening" of the soil is betrayed by the

FIG. 1.—RICE GROWN DURING RECLAMATION OF ALKALI SOIL NEAR BUSILI EGYPT.

FIG. 2.—RECLAMATION OF ALKALI LAND AT ABUKIR, EGYPT.

[To right of drainage ditch land is reclaimed and cotton is growing; to left of ditch is an alkali spot requiring further washing.]

FIG. 1.—SAMAR, USED FOR MAKING MATS, GROWN ON ALKALI LAND DURING THE PERIOD OF RECLAMATION.

FIG. 2.—PARTIALLY RECLAIMED ALKALI LAND AT ABUKIR, EGYPT, WASHED TWO YEARS AND SOWN WITH "DINEBA," OR BARNYARD GRASS.

appearance of a sort of pickle weed, and later of tamarisk, on the hitherto bare land.

If its condition after this first flooding appears to warrant the step, the land is plowed and a test crop of "dineba" is sown broadcast, generally about July 1. In case a stand of dineba, even though a poor one, is secured, the land is considered fit for berseem, which is sown at the beginning of autumn, immediately after the harrowing and second flooding, which follow the removal of the dineba. The seed is sown broadcast on the still wet soil. If, however, dineba has not given a fair stand, the land is kept flooded during the second winter, and a second test crop of dineba is sown the following summer. On the other hand, the success of the winter crop of berseem is considered sufficient evidence that the land is ready for cotton, which is put in the following spring.

The transition from bare, salty lake bed to productive cotton fields generally requires about three years under this method of treatment. Particular care is taken during this period not to plow to a greater depth than 6 or 8 inches, in order to avoid mixing the subsoil (which at a depth of 2 feet, or sometimes less, remains quite salty) with the washed surface soil. For this reason only the shallow native plow is used. Nor can cultivation be relaxed, even for only a few months, after reclamation has once begun. The salts in the lower levels of the soil soon reach the top again if the land is left fallow, in which case the entire process must be repeated. Eternal vigilance is assuredly the price of safety in reclamation work of this sort.

Dineba probably owes a large part of its usefulness in this regard to other things than an essential hardiness in the presence of salt. Being a shallow rooting plant, and being grown under these reclamation conditions with frequent and abundant floodings, it is probable that the roots go no farther into the soil than the depth which is kept thoroughly washed during the entire life of the plant. As a matter of fact, determinations of salt content of the soil in dineba fields near Alexandria showed the plants to be entirely killed off or prevented from growing at all by a comparatively small amount (0.7 to 1.4 per cent) of salt in the surface foot of the soil, while healthy plants were not found in the presence of more than 0.6 per cent soluble salts in the surface foot.[a] These facts would indicate that this grass is actually less resistant than such deeper rooting plants as alfalfa and cotton; but, as the culture of the latter crops does not permit incessant flooding of the land, they are not adapted to use in the first

[a] Mr. Anderson, manager of the Abukir company's lands, states that dineba can endure the presence of 2 per cent of salts, and will attain its full growth in 1 per cent. His results are probably based upon soil samples taken to a greater depth than the surface foot or two, the subsoil on much of the Abukir land being decidedly saltier. But it is not likely that dineba roots go deeper than 1 foot into the soil.

stages of reclamation. Some authorities in Egypt regard dineba as more resistant than rice, but a few observations made by the writers point to the opposite conclusion. Sorghum, which under American conditions will probably be found a more useful reclamation crop than dineba, is essentially a much more resistant plant.

The cheapness of the seed is another important factor in the choice of dineba as a reclamation crop. Being an abundant weed in rice fields, its seeds form a large part of the screenings, and can be bought at Rosetta for less than $1 per bushel.

Dineba is either pastured off standing or is cut and fed green. A good crop can sometimes be cut or grazed off twice during the six or eight weeks it is in the land. This grass is particularly relished by the water buffalo, which is so important a farm animal in Egypt. In favorable locations good pieces of standing dineba were sold off the land, for cattle feeding, at the rate of $7.50 per acre, in 1900.

SORGHUM.

Sorghum, a small, loose-headed variety of *Sorghum saccharatum*, locally know as "negro," is sometimes planted instead of dineba as a first crop on salt lands in process of reclamation; but its importance in this regard is overshadowed in Egypt by that of other crops. Sorghum grown on such land is generally fed to stock, although the grain grown on other soils is an important article of food with the "fellaheen" or agricultural laboring class.

RICE.

Rice is the second great reclamation crop of the country. (Pl. LXXX, fig. 1.) The rapidly growing, although otherwise inferior, "Sabeini" variety is preferred for this purpose, although not because it appears to be a more alkali-resistant kind. It is not sown before the beginning of August, when the Nile flood is almost at its height and water is abundant. On the other hand, "Sultani" rice, although a more valuable grain, must be sown in May in order to ripen its seeds by October, and this requires much water in the early part of the summer before the flood has begun. In seasons of exceptionally low Nile, such as have recently occurred for several successive years, Sultani rice must suffer in some localities in order that the more important cotton crop receive plenty of water during the early part of the summer, so that this variety is not generally adapted to use as a reclamation crop. The Sabeini variety occupies the land only about seventy days, ripening at about the same time as Sultani. The introduction into Egypt of a variety of rice that will grow as rapidly as Sabeini, but yielding a more valuable grain, would be a great boon to owners of salty land in the northern part of the Delta.

As in the case of dineba, the use of rice as a reclamation crop

probably depends largely upon its power to withstand the abundant water with which the land is flooded and washed while the crop is growing. Its roots are very shallow, and probably do not penetrate deeper into the soil than the limit reached by the water with which it needs to be frequently and abundantly flooded to secure a good crop; it is given about as much water as the drainage ditches can take care of. The subsoil, where salts are accumulated in greater quantity, is probably out of reach of the roots, yet on the whole rice appears to be more resistant than dineba to an excess of salts. An examination was made of the water standing on a field planted to rice and in process of reclamation near Alexandria, and the water was found to contain 150 parts per 100,000 of soluble salts, while the first foot of soil under the water contained 0.8 per cent of soluble salts. A good stand of rice was secured here. In a field in the same neighborhood rice was just growing in a soil containing as high as 1.8 per cent of salt in the surface foot. The general opinion appears to favor the view that it is a distinctly alkali-resistant plant. The limit of endurance for Sabeini rice, as determined by Mr. Lang Anderson, of the Abukir company, is about 0.5 per cent soluble salts in the soil. To what depth is not stated.

The seed of Sabeini rice costs two and one-half times as much as that of dineba, and the labor involved in producing a crop is much greater, but, on the other hand, the crop is more valuable. Yet, unless the yield is good, this kind of rice is not considered a paying crop. It requires much more water than dineba, but as it is a "Nili" or flood crop this is not a serious objection. In fields that are not to be permanently devoted to rice cultivation the series of crops on the gradually improving land is practically the same as in the case of dineba, berseem following rice as a winter crop, and being succeeded in its turn by cotton, the goal of most reclaimers of alkali land in Egypt.

Rice is frequently used by the fellaheen in their attemps to reclaim small fields by surface flooding (colmatage) without underdrainage. In such cases the crop is often a failure the first year, but generally succeeds the second season. But when another crop, cotton, for example, is tried in land thus treated, it is quickly seen that permanent reclamation can rarely be accomplished in this way. The salts soon rise once more to the surface.

SAMAR.

Samar (*Cyperus laevigatus*) is grown as a reclamation crop, chiefly in the Wadi Tumilat region, in the eastern part of the Delta. (Pl. LXXXI, fig. 1.) It is a reed, closely related to the papyrus plant, which furnished the ancient Egyptians with writing paper. Like rice and dineba, it is essentially a marsh plant and can endure for a

long period the presence of large quantities of standing water, the crop being kept flooded as much as the water available will permit. This, with its shallow habit of rooting and its rapid growth, renders it peculiarly useful as a reclamation crop.

That samar is essentially alkali-resistant is very doubtful. It is more likely that its value as a reclamation crop depends chiefly upon the fact that the roots do not penetrate below the stratum of soil that is kept thoroughly washed by flooding. Those who have watched the behavior of both crops upon salt land are of opinion, however, that samar will resist larger amounts of salt than will rice. Mr. Langley, inspector of the First Irrigation Circle in Egypt, who has given considerable attention to this crop as an aid in reclaiming alkali land, states that "the success of samar is assured where rice can not grow the first year." He maintains that although some land is too salty even for samar without a preliminary year of washing, it can safely be put in upon land too salty to produce a crop of rice, and that it is further preferable to rice in being able to go without watering from ten to twenty days without serious injury. This recommends its use in parts of the Delta where the amount of water available in summer is insufficient to insure a constant supply for rice. Mr. Langley also believes that samar "absorbs salt from the soil more rapidly than any other crop, and that it ameliorates the land more successfully than rice culture, especially in the first year." If this is really the case, the nature of the crop being such that the great bulk of it is entirely removed from the land, samar should prove a very effective agent in reclaiming salty soils.

The production of a good crop of samar is regarded by Mr. Langley as a sufficient indication that the land is ready for rice or for berseem, to be followed in the succeeding summer by cotton.

The three-year rotations chiefly practiced in reclaiming salt lands of the Wadi Tumilat region are as follows:

(1) LAND VERY SALTY.—Washing, samar, cotton. If the cotton succeeds, the reclamation is considered complete. Otherwise recourse is had to samar for another year, and the land is thus rewashed.

(2) LAND MODERATELY SALTY.—Samar, rice, cotton; or rice, samar, cotton; or samar, samar, cotton.

(3) LAND SLIGHTLY SALTY.—Samar, cotton, maize,[a] the last being recognized as a less resistant crop than cotton. In newly reclaimed land the advantage is recognized of returning every three or four years to rice or samar, with the accompanying thorough washing, even though crops of cotton or of maize have been produced in the

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[a] Sometimes the land is merely washed in summer, sown to berseem the same fall, and to cotton the following spring. In other cases a winter crop of barley, succeeded by a summer crop of maize, follows the first summer's washing. Generally, however, samar is the first crop.

meantime, as a means of preventing the return of salts to the surface of the soil, particularly in the neighborhood of drains.

The following will give some idea of the efficacy of samar as a reclamation crop: Mit Afifi cotton in the Wadi Tumilat region yielded 200 to 300 pounds of fiber on newly reclaimed land which had borne a crop of rice the year preceding and of samar the year before that. Twelve cents a pound was obtained for such cotton in 1901 and 17¼ cents in 1900. A crop of equally good appearance was produced on land that had borne samar the previous year and had received its first washing the year before that. Land which had been in rice the year before, preceded by a year of samar, brought about 20 bushels of shelled maize to the acre. Another field, which had been washed only the preceding summer and sown to barley during the intervening winter, brought 35 to 40 bushels when planted with seed of an American variety of maize ("Durra Amerikani"). An examination of the soil in this field showed that very little salt—less than 0.3 per cent—remained in the surface foot.

Samar is sown between the 1st of April and the end of July, while the crop is removed from the land from July 1 to November 30, according to the date of sowing. Instead of seed, pieces of the rootstock, set out at intervals of 18 inches, are planted. The plants grow rankly to a height of 6 or 8 feet. An objection to the use of this plant in rotation is that its roots and rootstocks form a strong mesh in the soil. Much labor is needed to remove this tangle of underground parts before other crops can be put into the land.

Apart from its value as a "reclamation crop," samar furnishes material for making basket-ware and mats of excellent quality. These mats have long enjoyed a reputation in the local market, and are becoming known elsewhere. They are woven from strips made by splitting the previously dried triangular stems. Attractive patterns in various colors are produced. The net value of the crop from an acre of good samar is said to be about $35, while an acre of rice is worth in the same region about $25, after deducting the expense of growing it. Samar mats sell in the local market at about 30 cents a square yard.

BERSEEM.

Berseem, or Egyptian clover, being capable of growing in flooded soils, finds an important place in reclamation work. It is a winter crop, and almost invariably follows the summer crop of dineba, rice, or samar, where one or the other of these serves as the first test crop in salt land. For Upper Egypt especially, where questions of water supply do not permit the extensive use of the latter crops, Mr. Willcocks has recommended the abundant flooding of the winter crop of clover, in connection with the establishment of proper underdrainage, as an efficient means for washing out the salts as often as they show a tendency to accumulate near the surface.

Berseem has been thought to be somewhat resistant to alkali, but is even less so than dineba, according to results obtained by the writers. Mr. Anderson, of the Abukir Land Company, puts its limit of endurance at 0.5 per cent, hence somewhat lower than that of alfalfa in the United States. It is probable that the shallow rooting habit of the plant and the abundant watering it receives tend to keep the small depth of soil reached by its roots thoroughly washed; and that this largely accounts for the supposed power of resistance, just as in the case of rice, dineba, and samar.

COTTON.

Cotton is much grown in Egypt upon land that is more or less salty, particularly in those areas near the coastal lakes of the Delta, where reclamation has been undertaken upon an extensive scale. Since alkali is more or less abundant in parts of the Southwestern United States, where an effort is being made to introduce the cultivation of Egyptian cotton, the facts as to its degree of resistance are much needed. A good opportunity was offered to study this question at Abukir, near Alexandria, where cotton is generally planted wherever reclamation has been going forward for several years. Occasional fields, where the washing has not yet been thoroughly completed, show spots of salty land among the healthy cotton, with perhaps a few scattered salt weeds or an occasional more resistant cotton plant to accentuate the bareness of the ground. (Pl. LXXX, fig. 2.) In such spots careful borings were made, first amid the good cotton, then at the roots of the scattered more resistant plants, and finally in the bare spots where no cotton grew. The percentage of salt content of the surface 2 feet of soil was ascertained to be in each case, as follows: Healthy stand of cotton, 0.6; occasional resistant plants, 1.8; bare spots, destitute of cotton, 2 and over. These figures indicate an unexpectedly high degree of resistance in the cotton plant, marking it as one of the very foremost in this respect of the world's great crops. That cotton is alkali resistant was already more than suspected, however. Reports received last spring from the Pecos Valley in Texas and New Mexico pointed to this conclusion with respect to ordinary Upland cotton. In Egypt, too, the fact is well known. Mr. Foaden, secretary of the Khedival Agricultural Society, wrote some years ago:[a] "The percentage of sodium chlorid present in the majority of the soils of the cotton-growing district is somewhat high. The average of the analyses already given is 1.5 per cent, and it may certainly be said that in the great majority of soils 1 per cent and over would be found."[b]

Jannovitch cotton, of which seed was imported into the United

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[a] Bulletin No. 42, Office Experiment Stations, U. S. Dept. Agr., p. 11.

[b] This statement is probably based upon analyses of samples taken to a greater depth than 2 feet, as otherwise it almost certainly overstates the case.

States by Mr. Fairchild, of the Department, is reported by him to have grown in soils containing 1 to 1½ per cent of alkali. There was formerly cultivated in Egypt a kind of cotton known as "Gallini," supposedly a derivative of American Sea Island. This variety was reputed to be more resistant to alkali than other types of cotton grown in Egypt, although in most respects it did not answer to Egyptian requirements. The fiber is described by Mr. Foaden as of good quality, although the yield per acre was comparatively small.

The effect of considerable salt in the soil upon the quality of the cotton fiber does not appear to be harmful, provided the amount of salt does not greatly exceed 1 per cent. Indeed, there appears to be a belief, not only among the fellaheen but on the part of well-informed observers, that a positively beneficial effect is exerted, at least by common salt (sodium chlorid). Mr. Bonaparte, of the Khedival Agricultural Society, states that an overproduction of leaf and stalk is avoided, and a tendency to ripen early is developed in cotton grown in salty land. Length, strength, and color of fiber are quite commonly believed to be improved by the presence of a moderate amount of salt in the land or the irrigating water.

Even where a considerable amount of salt is present, as in certain soils around Alexandria, Mr. Foaden found the fiber to be "not so inferior as might be expected." The strength was fairly good, but the fiber was shorter than in less salty land. The tendency to earlier maturity of the crop in "alkali" land is shared by cotton with many other plants. As a similar effect is known to be commonly produced in dry soils and dry weather, we have here further evidence that a salty soil, even though saturated with water, is dry to the plant because of the increased difficulty experienced by its roots in taking up water.

As to the effect upon yield of the presence of an excess of soluble salts in the soil, there is as yet no definite information. It is a question well worth investigating both by direct experiment and by the comparison of returns of yield from salty land with those from land where there is no excess of salts.

Conclusion.

Of the crops used for the specific purpose of aiding in reclaiming alkali lands in Egypt, probably only two, sorghum and berseem, will be found practically useful in the United States. In almost every important area known to the writers where the accumulation of "alkali" in the land is a serious problem, the water supply available in summer is too scanty to allow the extensive use of dineba, rice, or samar, even were any of these crops suitable to American conditions as to labor, market, and general agricultural methods. Sorghum already enjoys a considerable reputation in the Southwest as a summer crop

for use in reclaiming salt land, and its use will probably continue to increase. Barley appears to be on the whole the most useful winter crop for such land. Berseem offers great possibilities in the southern part of the arid region as a forage crop and a soil renovator in rotation with cotton, and as a winter soiling crop in orchards. It may very probably find still another important function, that of an agency in reclamation, wherever the abundance of the water supply in winter will warrant its use. A thorough trial of this clover where salt lands are to be reclaimed is therefore most desirable, particularly in the Southwestern States and Territories.

SOME PRACTICAL RESULTS OF EXPERIMENT STATION WORK.

By W. H. Beal,
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Introduction.

It may be justly claimed that the United States has in its National Department of Agriculture and the State agricultural experiment stations the most complete system of agricultural research in the world, and that the results obtained through these agencies have had a wider application and have influenced to a greater extent the masses of farmers than has been the case in any other country. Agricultural experiment stations are now in operation in every State and Territory of the United States, including Alaska, Hawaii, and Porto Rico, and steps have been taken under Government auspices to establish agencies for agricultural investigation in the Philippine Islands. There are 60 such stations, employing nearly 1,000 trained scientific and practical men in their work.

The annual income of these stations in 1902 was $1,328,847.37, of which sum $720,000 came from the Federal Government and $608,847.37 from State appropriations and other sources. During the fourteen years of their existence as a National enterprise there has been expended in their maintenance about $14,000,000, of which $10,000,000 came from the National Treasury and about $4,000,000 from State sources. The agricultural products of the United States during the same period are valued at over $40,000,000,000. In other words, the outlay for agricultural investigation has been at the rate of $1 for nearly $3,000 worth of product. This can not be considered an extravagant outlay in view of the magnitude and diversity of the agricultural interests of the country and the success which has been attained by the experiment stations in promoting those interests.

According to the Twelfth Census, there were in 1900 about 10 million persons, or about one-eighth of the entire population, engaged in agricultural pursuits in the United States. The total value of farm property (land, buildings and other improvements, implements and machinery, and live stock) in that year was, approximately, $20,500,000,000. The value of farm products in 1899 was, according to the same authority, $4,739,000,000, which represents an increase of over 50 per cent in ten years. This shows that the productive capacity of

American agriculture is rapidly increasing, and it is the purpose of this article to point out some of the ways in which the work of the experiment stations is assisting in bringing about this result. In doing this, however, it is impossible to draw a sharp line of distinction between what has been done by the Department of Agriculture and what has been accomplished by the stations, since the relations between the two are so close and the lines of investigation to such a large extent identical that they really form one system of agricultural research. In very few of the examples cited, therefore, can exclusive credit be claimed by the experiment stations. In many cases, and especially in the introduction of new varieties and industries, the Department has been the pioneer and leader, the stations, however, rendering most efficient service by testing the results of Department work on a large scale and adapting them to local needs and conditions, thus giving them a wider usefulness. This plan of cooperation, which is being strengthened from year to year, serves to unify the work and to build up a system of agricultural research which comprehends the nation as a whole, and yet meets the varied needs and conditions of an extremely diversified agriculture.

In attempting to show how and to what extent the work of the experiment stations has modified and benefited agricultural practice, it is necessary to take into account broad general educational results as well as special examples of their influence. "Broadly speaking, the most important results of the work of the American stations during the past quarter of a century, and especially during the past decade, have been educational;" but this subject has been very fully discussed elsewhere[a] and need not be further considered here.

Specific Examples of the Influence of Experiment Station Work on Agricultural Practice.

In addition to the broad educational results just referred to, the benefits of which are evident to every student of agricultural affairs, although not capable of being measured in dollars and cents, there is no lack of specific examples of the beneficial influence exerted by station work in improving the agricultural practice and benefiting the farming interests of the country. The stations are conducting a wide range of scientific research in laboratory and plant house, and an equally large amount of practical work in field, orchard, stable, and dairy. Their investigations include studies of climatic and weather conditions as related to plant growth; soil investigations and fertilizer experiments to find the best means of maintaining and increasing the productiveness of the soil; irrigation and drainage experiments to increase the area of productive lands; breeding and culture of plants to increase the yield and improve the quality of farm, garden, orchard, and greenhouse crops of all kinds; breeding and feeding

[a] Yearbook of the Department of Agriculture for 1899, p. 547.

of farm animals to increase production and improve the quality of meat, milk, and wool; dairying to improve the output of butter and cheese; inspection of fertilizers, foods and feeding stuffs, dairy products, etc., to protect farmers against fraud, and a large number of associated lines of work which it is not necessary to enumerate here. These various lines of investigation, which cover the whole field of agricultural operations, may be classified as follows: (1) Original investigations to discover new facts of value to agriculture; (2) experiments to demonstrate the scientific and practical value of facts already known and their applicability to special conditions; (3) studies of natural agricultural conditions, resources, and possibilities; and, (4) inspection and control work to protect the farmer against fraud. Investigations of the stations are intended primarily to supply information which it is impossible for each individual farmer to search out for himself, and the controlling purpose of their work has been (1) to develop the agricultural resources and promote the farming interests of the particular regions in which they are located, and (2) to advance the cause of scientific agriculture at large. The operations of the individual station are likely to be of a mixed character, including more or less of each of the general classes of work named, but varying in the prominence given to any particular class as the local and regional conditions and needs of the State or Territory in which it is located demand. Thus, in the more recently settled portions of the country special prominence is given to demonstration experiments and to the dissemination of information of a very practical character, while in regions where agriculture is more advanced original investigations naturally receive more attention; or, for example, in the older States, in which the use of fertilizers has become a necessity, a large amount of attention is given to the inspection of that commodity, a line of work which is of course unnecessary in those regions where fertilizers are not yet used to any considerable extent.

The following summary of some of the more prominent results of station work may serve to indicate the character and extent of station influence on agricultural practice. It should be clearly understood that this is a partial summary and mentions only a few of the many equally valuable results of the work of the stations to illustrate their varied activities.

SOILS AND FERTILIZERS.

Probably in no one particular has the work of the stations been of more direct benefit to farmers, especially in the older States, than in the inspection and study of fertilizers. The beneficial effects of this work are becoming more apparent every year. As a result of it, an industry the annual sales of which exceed $50,000,000 and which directly affects over thirty States of the Union is conducted on a high

plane of honesty, fraud and extravagant claims having been largely eliminated. The more successful farmers are buying fertilizers more intelligently and economically, and know what they are using in terms of nitrogen, phosphoric acid, and potash. For example, as a direct result of the investigations and advice of the New Jersey station, organizations of farmers have been formed in the truck-growing districts of that State for the purchase of unmixed fertilizing materials, and are thus effecting a saving of from 25 to 40 per cent in the cost of their fertilizers, while at the same time securing better results as regards earliness, yield, and quality of product. As the farmers of New Jersey pay annually about $1,200,000 for their fertilizers, this means a saving, if applied to the whole State, of from $300,000 to $480,000 each year, or ten to fifteen times as much as the two experiment stations in New Jersey cost the State and nation annually and nearly as much as they have cost from their organization in 1880 to the present time. Equally striking results have been obtained in other States in which the stations have given particular attention to the subject of fertilizers.

The work of the stations on fertilizers has been made to exert a widespread beneficial influence not only through the station publications, correspondence, personal advice, etc., but by means of cooperative experiments with the farmers themselves under widely different conditions of soil, season, and crop. The farmer has thus not only been taught the needs of the particular crop and soil experimented with and the relative merits of the fertilizers used, but, what is also of great importance, he has been taught how to plan and successfully carry out experiments for himself and to cooperate efficiently with the experiment stations in such work. A good example of the value and influence of such work is furnished by the experiments conducted by the Rhode Island station in cooperation with farmers in all parts of that State on the acidity and lime requirements of soils. These experiments have shown the very general distribution of acid soils in the State and have pointed out an effective remedy in the use of lime, information which is now being very generally applied in practice in that and other States with great benefit to their agriculture.

Many of the stations have given special attention to the economic utilization of the manurial resources of the farm, with the result that there is now in the more prosperous rural communities a higher appreciation of the value of farm manures and better methods for their care and use. As the annual loss to the farmers of the United States from waste of barnyard manure alone is reliably estimated at over $7,000,000, the value and importance of work which points out more effective and profitable methods of preserving and using this product are obvious. This better understanding of the value and use of farm manures is usually accompanied by a more intelligent and profitable use of commercial fertilizers to supplement such manures in general

farming, and the wider employment of cheap practical means of restoring the fertility of worn soils without the use of commercial fertilizers. On the other hand, the station investigations in regions where intensive farming or market gardening is practiced—as, for example, in certain parts of New Jersey—have shown the wisdom and profit of the liberal use of commercial fertilizers to replace to a large extent the heavy manuring with stable manure, which was formerly the general practice.

The stations have from the beginning taken an active part in investigations relating to the extremely varied soil conditions of the country, studying distribution of types, physical and chemical characteristics and deficiencies, and adaptability to different crops. The influence of such work by the stations and by the Department is seen in the more discriminating choice of crops for particular soils and use of fertilizers for special crops; in the more profitable and rapidly growing utilization of land under irrigation in the so-called arid regions of the United States, and in the reclamation and profitable use of considerable areas of swamp lands and of lands rendered useless for ordinary culture by reason of the presence of excessive amounts of soluble salts (alkali). It is also seen in the increased attention given to green manuring, rotations, and tillage to maintain the humus content and improve the moisture conditions of the soil, particularly in the cotton-growing region of the South and in the grain-growing regions of the West and Northwest (see p. 598).

INTRODUCTION AND ORIGINATION OF NEW AND IMPROVED VARIETIES OF PLANTS.

A fundamental purpose of all agriculture is the production of a greater variety, larger yields, and better quality of crops. It is natural, therefore, that the stations have from the beginning given a large share of their time and energy to investigations having these objects in view. The work in this line has included testing of varieties of field crops, fruits, and vegetables, to find those best suited to given regions and conditions, and to protect farmers against extravagant claims for new varieties; the orgination of improved varieties by breeding and selection; improved methods of culture and utilization of product, and protection against insect enemies and plant diseases. Attention has been directed persistently to the introduction of new crops, to the improvement of old varieties, and to finding new and more profitable uses for the crops commonly grown.

The staple crops of the country, such as corn, wheat, cotton, and tobacco, have been the subject of an immense amount of investigation, covering nearly every phase of their chemical composition, improvement by breeding and selection, culture, manuring, harvesting, curing or storage, and utilization. Many of the results have

been of direct practical value, materially influencing the methods followed by farmers and leading to a greater diversification of agriculture in many regions.

INTRODUCTION OF NEW VARIETIES.

In the introduction of new varieties a striking example is given of the valuable service the stations are rendering in supplementing and extending the work of the Department of Agriculture and giving it local application. The Department has from the beginning of its career been carrying on work of great value along this line, but this work is undoubtedly being greatly strengthened by the cooperation of the stations.

In no respect has the benefit from station work in connection with the introduction of new varieties been greater than in the case of cereals. Notable instances of the successful introduction of new cereal crops are Manshury barley, for which the Wisconsin station is mainly responsible, and which has materially increased the yield of barley over a wide region, with results worth millions of dollars, and Kafir corn, first distributed by this Department in 1886 and introduced to practical use on a large scale by the stations in California, Kansas, and Oklahoma. Kafir corn has been found specially suited to conditions in which the rainfall is too scanty for the most successful culture of corn. The crop in Kansas alone in 1899 was valued at over $6,000,000.

A variety of oats introduced by the Department, and tested and improved by the Wisconsin station among others, has been widely distributed and grown, with results which indicate that its general introduction will be followed by an average increase of yield which Professor Henry estimates at from 3 to 5 bushels per acre. As the area devoted to oats in Wisconsin alone in 1901 was, according to the Department Statistician, 2,290,288 acres, producing 66,647,381 bushels, estimated to be worth $25,992,478, this would mean, if maintained throughout the State, a gain to the farmers of Wisconsin annually of from $2,400,000 to $4,400,000 on the oat crop alone.

The macaroni wheats imported and distributed by the Department and carefully tested under varying conditions by a number of the stations have proved so successful as to give reasonable assurance that in a few years the United States will not only produce all of the macaroni it consumes, but will supply a considerable proportion of the macaroni and macaroni flour used abroad.

The investigations of the stations in Alabama, Tennessee, Mississippi, Louisiana, Florida, and other Southern States, supplementing the extensive work of the Department on grasses and forage plants, have done much to convince farmers that forage plants of many different kinds may be more successfully grown throughout the South than has heretofore been supposed possible, and thus have laid the

foundation for a wide development of the live-stock and dairy industries of that region. The hairy vetch, studied especially by the Alabama and Mississippi stations, promises to prove of great value to those States. Similar experiments on cowpeas by a large number of stations have had a marked influence in extending the use of this valuable plant for soil improvement, for soiling, and for hay, especially in the southern half of the United States, and in introducing better methods of culture of the crop.

Careful studies of the value and use of alfalfa by the stations in Colorado, Utah, and other Western States have done much to extend the area of culture and increase the usefulness of this crop in the irrigated region, while recent experiments by a number of stations in other parts of the country have shown that this crop has a much wider usefulness than has hitherto been supposed. The Turkestan alfalfa, distributed by the Department and tested by a large number of the stations, has been shown to have qualities of hardiness and vigor which will enable it to withstand frost and drought to a greater degree than the common variety, and will thus still further extend the limits of profitable production of this valuable forage plant.

The introduction of crimson clover, which has been found so valuable as a winter cover crop for grazing and for hay and seed, has been largely due to experiment-station influence.

In some of the Northwestern States, where successful fruit growing depends so largely upon hardiness, the stations have led in the introduction of hardy varieties of stocks and fruit, the Iowa station being the pioneer in this work. Importations by that station of hardy European fruits were made as early as 1882.

The Department and the Connecticut State station, cooperating with local tobacco growers, have within the last three years demonstrated the practicability of growing a fine grade of Sumatra wrapper tobacco under shade in the Connecticut Valley, thus adding a new and profitable industry to our agriculture and increasing the value of the light lands of the Connecticut Valley, according to Professor Whitney, over 200 per cent.[a]

The investigations on sugar beets conducted throughout the country by the stations cooperating with the Department have had a practical outcome in the successful establishment of over 40 beet-sugar factories in different States, and have shown in a very definite way in what regions this industry has the best chance of success. It is reported that the area devoted to sugar beets in 1901 was 175,000 acres, producing 1,685,000 tons of beets, worth to the growers probably $6,000,000 to $7,000,000. This industry has come into existence in the United States since 1890. For, although sugar beets were successfully grown in Massachusetts more than forty years ago, and Goessmann, at the Massachusetts Agricultural College, as early as 1870

[a] Bulletin No. 20, Bureau of Soils, U. S. Dept. Agr.

demonstrated the feasibility of growing beets suited to the manufacture of sugar, it was not until about 1890 that the Department of Agriculture, with the cooperation of the experiment stations, commenced the systematic experiments which have put the industry on its present basis. Of this industry a recent writer[a] says:

To diversify agriculture, as in the West; to succeed a waning industry, as in the lumber regions of Michigan; to add another item to the nation's list of products, reducing its need of importation—these are some of the broader advantages claimed for the beet-sugar industry. With a large area adapted by soil and climate to sugar-beet raising, and with capital in abundance seeking profitable investment, it will be strange if the United States does not find a way to make the industry a prominent and permanent one.

Although the profitable production of beets for sugar making has received so much attention, the long-established cane-sugar industry has not been neglected. The work of the Louisiana stations has been so successful in preventing losses by improving sugar-house methods and methods of culture, and in introducing improved seedling varieties, that the Sugar Planters' Association of that State has recognized the work by liberally contributing to the support of the stations.

ORIGINATION OF IMPROVED VARIETIES.

While the stations have done a valuable work for agriculture by introducing and promoting the culture of varieties which they have demonstrated to be of value, the best prospect for future advance with reference to plant production seems to lie along the line of the scientific origination of new varieties by breeding and selection, a feature of agricultural investigation which has been enthusiastically undertaken in recent years by a number of the experiment stations, but particularly those of the grain-growing region, cooperating with the Department.

Speaking of the work of the Minnesota station in breeding wheat, a recent writer[b] says:

Enough has been demonstrated at this station and upon the farms of the State in actual farm handling to show that the wheat crop of the world is now to be splendidly strengthened; that the theorists who have predicted ultimate starvation through impairment of the world's dietary are driven to other speculations; that it is quite possible, indeed, that it is now an established fact, to produce wheats superior to the best the world has had. By the use of the new wheats the crop of the hard-wheat region of the Northwest may be increased by from 3 to 5 bushels per acre, which, reduced to a practical basis, assures an increase in the wealth of three States of from twenty-five to forty millions of dollars annually.

It is very evident that the yield and quality of wheat in Minnesota is undergoing a marked improvement as a result especially of the distribution of seed of two improved varieties originated by the experiment station of that State, and similar improvement, though probably

[a] C. M. Harger (Outlook, 72 [1902], No. 2, p. 131).
[b] W. S. Harwood (Scribner's Magazine, 31 [1902], No. 6, p. 651).

less marked, is undoubtedly resulting from similar work by other stations in the grain-growing region.

No less interesting and valuable is the work of the Illinois station in corn breeding, one practical result of which has been the formation of the Illinois Seed Corn Breeders' Association, a chartered organization, with a limited membership of reputable and well-known corn growers pledged to select and grow their seed corn according to definite rules formulated by the station, and to sell only their own crop. The success of this enterprise has been phenomenal. All of the available supply of the improved seed is rapidly disposed of to farmers, and much of it is engaged in advance. The work of this station on corn is proving to be far-reaching in its results, not only in improving the general quality of seed corn, but in inducing practical men to undertake breeding for special qualities—for protein, for oil, or for starch—which the station has demonstrated to be entirely feasible.

While perhaps the most striking and valuable results have been obtained in the origination of new varieties of cereals, some very useful results have been secured in similar work on forage plants, fruits, etc. Thus Hansen, at the South Dakota station, is making considerable progress in developing varieties of fruits suited to a region which presents almost insurmountable obstacles to the culture of ordinary varieties, and the value of the Ignotum tomato and the Hunn strawberry, both originated by station men, is generally recognized.

IMPROVED METHODS AND SYSTEMS OF CULTURE.

The stations have not only been useful, as pointed out above, in introducing new and improved varieties of farm crops, but they have been very active in investigations which have led to the adoption of better methods of culture. A notable example of this is found in the substitution in the grain-growing region of rotations to conserve soil fertility for the exhaustive system of continuous grain cropping and bare fallow, practices which have heretofore been generally followed and which have caused some of the best wheat lands, such as those of the famous Red River Valley, to begin to show a marked decline in productiveness. In parts of the same region, subject to severe summer droughts, the stations have demonstrated the advantages and urged with considerable effect on practice the cultivation of winter wheat, which matures earlier than the commonly grown spring wheat and so in large measure escapes injury from drought. The more extended cultivation of winter wheat will largely increase the productive capacity of the grain-growing region.

The Georgia station has introduced in that State a method of spring seeding of oats which obviates the danger of winter killing that has heretofore rendered the culture of that crop very precarious in Georgia and elsewhere in the South.

The stations of the Northwestern States are doing much to extend

the limits of successful corn culture by showing that by careful selection of varieties and modified methods of culture suited to the conditions this crop may be grown successfully in regions heretofore considered entirely unsuited to corn culture. This is proving of immense value to those regions in increasing the available supply of food and forage. The investigations of the Illinois, Ohio, Indiana, and other stations, which demonstrated the superiority of shallow over deep cultivation of corn, have produced widespread changes in the culture of that crop.

The method of handling corn fodder in the South is being materially modified for the better by station work showing the costliness of the old practice of stripping and curing the blades and the advantages of using shredding machines which render a larger amount of good forage available at much less cost.

In the States west of the Mississippi River the conservation of moisture in the soil is an important factor in successful agriculture, and the stations in that region have done valuable work in showing the conditions under which the moisture is largely conserved, and by introducing subsoiling and other methods of tillage especially adapted to this purpose.

Irrigation and diversified farming are working a revolution in the agricultural methods of the western half of the public domain, replacing the ranch and the range by the small farm, orchard, and garden. This change is of course an inevitable result of normal development, but the stations have had no small influence in directing the movement along safe channels and in securing the adoption of proper methods and practices. They have done much to correct errors in irrigation methods long in use and to introduce new methods which secure better measurement, distribution, and use of the water supply in a region in which water is more valuable than land and its just distribution and economical use essential to peace and prosperity. The stations in the arid region have also been of great assistance to newcomers not familiar with irrigation farming by furnishing information regarding methods applicable to the new conditions and crops most likely to succeed. Many of the early emigrants to the West were induced by interested persons to locate on lands and to attempt "dry farming" (that is, without irrigation) in regions in which the rainfall is in most years too scanty to supply the needs of crops. The result was general disaster, and many deserted towns and farmhouses on the semiarid plains bear silent testimony to the folly of the enterprise. That these lands, however, may in many cases be profitably utilized when properly managed and when "dry farming" is supplemented with irrigation farming has been shown by the work of several of the stations. The Utah station especially has achieved notable success in its study of the extent to which dry farming may be practiced with profit and of the conditions necessary to success. This

work is bearing fruit in the extension on a safe basis of what has heretofore been a very precarious system.

The investigations of the stations have given most important results in improving methods and practices in almost every line of horticultural operations. It can be reasonably claimed that present methods of orchard cultivation are due largely to the efforts of experiment station workers. The early spring plowing of orchards, followed by shallow cultivation during the most active period of wood growth, or until the middle or last of July, in most of the Eastern States, and the planting of leguminous cover crops at that time, as now practiced by most successful orchardists, can be quite clearly traced to the work and teachings of the experiment stations.

Those investigations which have related especially to the forcing of vegetables in the field and under glass have been a considerable factor in the rapid development of the business of supplying markets in the United States with a large amount of fresh vegetables at all seasons of the year, even in the States farthest north. Among the investigations of this character in which the stations have taken an active part are studies of proper methods of construction, heating, and watering of greenhouses, of crops best suited to forcing, and of the best methods of forcing. Professor Galloway[a] says:

> Probably nowhere in the world has the growing of plants in greenhouses attained such importance as in the United States. Other countries may have more imposing structures and larger individual areas of glass, but, taking the business as a whole, it may be fairly claimed that in up-to-date methods in almost everything pertaining to this special field of horticulture this country leads.

The growth of the horticultural industry in recent years has been remarkable, probably 100 per cent in the last ten years, and no small proportion of the increase has been due to the extension of culture under glass. According to the Twelfth Census there was 96,230,420 square feet under glass June 1, 1900.

A notable example of the influence of station work on horticultural, and particularly greenhouse, methods is the practice, which is being widely adopted, of sterilizing greenhouse soils by means of steam or hot water. The methods which are now being used for this purpose with great success and profit were first worked out and brought to the attention of practical horticulturists by the Massachusetts station.

Another example of station influence in promoting the forcing of vegetables is found in the introduction, largely through station effort, of winter culture of lettuce in eastern North Carolina, an industry now said to yield an income of probably $100,000 annually. The North Carolina station also claims credit for inaugurating the now well-established and flourishing industry of growing flowering bulbs in the same region.

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[a] Yearbook of the Department of Agriculture for 1899, p. 575.

Following the work of M. B. Waite, of this Department, showing the sterility of many varieties of pears to their own pollen and the necessity of mixing varieties in orchard planting to secure proper fertilization, many of the stations have made investigations along the same lines with plums, grapes, apples, and many other fruits, and many varieties of these fruits have been shown to be self-sterile. This work must of necessity prove valuable, though there is no way of measuring its value. The facts, however, have been so widely published and discussed that it would seem unlikely that at this time any large blocks of fruit trees are planted without considering this point and mixing the varieties in such a manner as to insure cross-pollination.

Methods of onion culture have been modified by station investigations. The Ohio station discovered independently, but at the same time with T. Greiner, that onions started in the greenhouse or under frames from seed and then transplanted to the open field produced larger onions and earlier and heavier crops than by the usual method of field seeding. Experiments at other stations have largely confirmed these conclusions. The method has been found especially applicable to the growing of the large foreign varieties, like the Bermuda onions, in some of the Northern States, and is quite widely followed.

Other lines of station work that would appear to be influencing horticultural practice are studies of methods of olive pickling in California and, in general, the whole subject of olive culture; the irrigation of fruit and vegetables in Eastern humid regions close to cities, the winter irrigation of deciduous fruits in Arizona, subirrigation in greenhouses, bench grafting of resistant vines in California, and liberal manuring of early market garden crops with nitrogenous fertilizers in New Jersey.

PROTECTION AGAINST INJURIOUS INSECTS AND PLANT DISEASES.

The reduction of the enormous losses caused by the ravages of insects and plant diseases is a problem to which the Department and the stations have for many years been giving their earnest attention with most gratifying results. Through their efforts the application of insecticides and fungicides as means of protection against injurious insects and plant diseases has become very general, and the benefits and profits resulting from the practice are no longer questioned. The idea of spraying goes back more than a hundred years, but the system has come into general use only during the last ten or fifteen years. The experiment stations have made many spraying experiments with positive and striking results; their work has been published in bulletin form and sent out to farmers, the agricultural press has reprinted the essential parts of it with favorable comments, and farmers' institute workers have used the same data to justify their advice as to the

desirability and profitableness of spraying. It is not assuming too much to say that the stations, with the Department, deserve a very large measure of credit for the present methods of controlling plant pests by spraying. Striking evidence of the readiness with which farmers and fruit growers will now adopt promising means of plant protection is furnished by the fact that the method of formaldehyde treatment of smut of oats, proposed by the North Dakota station, was almost immediately put into use by over 25,000 farmers in the State of Wisconsin alone, with the prospect that the number using the method will rapidly increase. As the estimated loss from oat smut in Wisconsin varies, according to Professor Henry, from $3,000,000 to $7,000,000 annually, according to the season and other conditions, the great value of an effective means of prevention of the disease is obvious.

A few years ago the farmers of the noted potato-growing region of Aroostook County, Me., found their business seriously menaced by the ravages of insects and of blight and other diseases. Through the advice and under the direct supervision of a representative of the Maine station they were led to adopt a system of spraying which has proved a very effective protection and has insured the profitable continuance of potato growing in that region, the annual output of which is over 6,000,000 bushels.

Examples of the beneficial effects of spraying and of its profitable application in farm practice could be multiplied almost indefinitely. There is hardly a serious insect pest or plant disease that the stations and the Department have not studied, and in most cases suggested a remedy for. The methods and apparatus for use in applying these remedies have been so simplified and perfected that the cost of treatment is almost insignificant, compared with the benefits derived. The outlay of a very small sum for spraying often means complete success as against total failure if such protection is not afforded.

STORAGE AND UTILIZATION OF FARM PRODUCTS.

The work of the Wisconsin station, following closely that of McBryde (now director of the Virginia station) at the University of Tennessee in 1879, was among the first to acquaint the American farmer with the process of storing green forage plants in silos and to explain the true value and proper use of the silage for feeding purposes. The station investigations on this subject have included the methods of constructing and filling silos, the best time for cutting the crops to secure the maximum amount of nutrients, increasing the richness of the silage by adding leguminous crops, and the feeding of the product. The rapid extension of the use of silage, especially in connection with dairy farming, and the very general adoption of the round form of silo, proposed by King, of the Wisconsin station, is directly traceable to experiment-station influence. The better

methods of handling corn fodder and the higher appreciation of its value as a feeding stuff are, as already intimated, largely due to the influence of station investigations on this subject.

The stations in the South and elsewhere have done much good in demonstrating the value of cotton seed and its products as feeding stuffs and fertilizers, and have thus added materially to the value of the cotton crop. The cotton seed annually produced in the United States is estimated to have a combined feeding and fertilizing value of some $150,000,000, a value which is not materially reduced by the extraction of oil. It is largely due to station influence that there is a rapidly growing appreciation of this product and a more general and economical use of it.

The South Carolina station has shown the possibilities of the sweet potato as a starch-producing crop, and has devised a simple method of drying the potatoes so that they will keep indefinitely, and may be handled and shipped more easily and cheaply. This means, if successfully introduced, a wider distribution and more extended use of this product of the farm.

In its studies of the value of cassava for starch making and for feeding the Florida station has secured results which promise to be of considerable value to the agriculture of that State.

The subject of the cold storage of fruit is being agitated at the present time by a number of the experiment stations, and some work has been done on this subject. The Department has shown that early apples and peaches can be successfully shipped in cold storage to England and sold at a profit. This promises to open up an entirely new outlet for the fresh fruits of this country and may prove especially valuable in seasons of superabundant crops.

ANIMAL PRODUCTION.

Station investigations relating to animal production have covered the whole range of the breeding, feeding, diseases, and management of domestic animals, and the results obtained have been no less valuable from a practical standpoint than those yielded by the studies in plant production discussed in previous pages.

According to the Twelfth Census, the value of animal products in the United States in 1899 was $1,718,990,221, or 36.3 per cent of the total value of farm products, the value of crops during the same year being $3,020,128,531. The value of live stock in 1900 was $3,078,050,041, representing an increase of nearly 40 per cent since 1890. The rapid increase in the value of farm live stock and animal products in recent years is unquestionably due to a considerable extent to station influence. In many localities the stations have done much good by encouraging the introduction of improved breeds of animals. The wide dissemination of the accounts of their feeding experiments with all kinds of animals and all kinds of feeding stuffs has brought

about a more general understanding of the principles of feeding and the adoption of more scientific methods of "balancing" rations of home-grown products with purchased concentrated feeds, with the result that better products are grown at less cost and with less draft on the fertility of the farm.

New methods have been adopted and old methods have in many cases been discarded as a result of such work. For example, the extensive experiments of the Wisconsin station showing that there is not only no gain, but an actual loss, in cooking corn, corn meal, barley meal, and wheat middlings for pigs have been widely quoted, with the result that much less food is now cooked for stock than formerly.

The work of several of the stations, but particularly those of Missouri, Texas, and Louisiana, on Texas fever, extending and making local application of the work of the Department, has materially aided in the improvement of the cattle industry in the region affected by this fever by furnishing a means of making cattle immune to the disease and thus rendering it comparatively safe to bring in high-bred animals for breeding purposes, and by preventing in large measure the spread of the disease to new regions through the movement of cattle.

Practically every other serious disease to which farm animals are subject in this country has at one time or another received attention by the Department and the different stations, and while the beneficial results are perhaps not so evident as in the case cited, they are clearly seen in the increased attention given by farmers to stable construction and sanitation and to the health and comfort of their animals, and by an increasing demand for information and advice regarding such matters. In short, farmers are to a larger extent than ever before discarding scrub stock for improved animals, feeding more economically and scientifically, and making more careful provision for the health and comfort of their stock, and no small share of the credit for this condition of affairs may be justly claimed by the experiment stations. With such results accomplished and such agencies at work, it is safe to predict that the next decade will show an improvement in the amount and quality of the output of animal products even more remarkable than that of the past ten years.

DAIRYING.

The stations have done work of great practical usefulness to farmers in the study of dairy problems, including the breeding and care of dairy animals, the handling of milk, and the manufacture of butter and cheese. The working out of practical methods and apparatus for the rapid determination of the fat content of milk, most perfectly accomplished by the Wisconsin station, but participated in by a number of stations; the researches regarding the chemistry and bacteriology of milk and dairy products; the elaborate investigations on cheese

making at the New York State station and on the ripening of cheese at the Wisconsin station; the practical experiments in butter making at the Iowa station—these and other investigations at the stations, combined with the dissemination of information regarding the results of work in similar lines abroad, have brought about a widespread revolution in the business of dairying in this country.

Following the perfection of the Babcock test, a large amount of work was done which showed the weight or volume of milk to be an unfair and illogical basis for paying for milk at creameries, and the "relative-value plan" was developed by the Iowa station, in which the fat content of the milk is taken into account, payment being made on the basis of the pounds of milk fat delivered. Subsequent work has shown that this, with a slight correction, is the proper basis for buying milk at cheese factories. This has resulted in a culling of herds, improvement of the cows kept, and increased profit.

The work in bacteriology has dealt with the extent and character of infection with micro-organisms, means of gaining access to milk, prevention by cleanliness in the stable and in handling, pasteurization, the use of pure or of definite cultures in butter making and cheese making, the nature of the changes in the ripening of cheese and the kinds of organisms causing them, and the means of controlling ripening.

By the discovery of the so-called curd test the Wisconsin station has provided an effective means of detecting tainted or defective milk at cheese factories, a matter which has caused a loss of from $100,000 to $200,000 each summer in Wisconsin alone.

The artificial cooling of cheese-curing rooms has received attention, resulting in practical suggestions for this purpose, which have been of much value to cheese makers. The demonstration by the Wisconsin station of the decided advantages of low-temperature ripening of cheese as regards safety and better control of the process and quality of the product promises to greatly modify and improve present practices in cheese making.

In many cases the stations have led in the introduction of dairying as an industry where it formerly received little or no attention. Thus, the credit for the successful establishment on a commercial basis of dairying in Utah may be fairly claimed as due largely to the efforts of the experiment station in that State; and the stations in other States have been equally successful in this respect.

In brief, it may be said that the farmers of the United States are keeping better dairy cows, feeding them more economically and scientifically, handling the milk in a better and more cleanly manner, and receiving a fairer price for it; and that more and better products—butter and cheese—are being made than ever before. In every one of these respects they have received substantial aid from the work of the experiment stations.

An idea of the present importance of the dairy industry of the United States and of the progress that has been made in the last ten years may be gained from the following figures from the Twelfth Census: In 1899 there were reported to be 17,139,674 dairy cows in the United States, producing 7,266,392,674 gallons of milk, or an average of 424 gallons for each cow. During the same year there were produced 1,491,871,673 pounds of butter and 298,344,654 pounds of cheese. The census figures show that the increase in milk production since 1889 was nearly 40 per cent, in butter production about 24 per cent, and in cheese production 16 per cent. The percentage increase in production exceeded that in the total number of dairy cows, indicating an improvement in the cows kept and an increase in the product per cow.

THE PROTECTION OF FARMERS AGAINST FRAUD.

The value of station work on fertilizers in protecting farmers against fraud and in disseminating correct ideas regarding the value and use of fertilizers has already been referred to. More recently the stations in a number of States have undertaken the inspection of foods, feeding stuffs, and dairy products, and of nursery stock for fungous diseases and insect pests, which promises to be as useful to farmers as the inspection of fertilizers has been. The effects of publication of the results of analyses of feeding stuffs found on the market, with explanations of the principles of feeding, and the nature and functions of feeding stuffs are becoming evident in a general way in the more intelligent purchase and use of feeding stuffs, but more specifically in the higher appreciation and larger and more rational use of meals of various kinds, corn by-products, such as gluten meal and feed, and by-products of the milling industry, bran, middlings, etc.

Besides the prevention of frauds by regular systems of inspection, the stations have also done much useful work in this line in other ways. For example, their tests of varieties of grain, vegetables, fruits, etc., have often shown farmers how extravagant were the claims made for new varieties of plants. Their tests of the purity and vitality of seeds, while not systematically conducted, have yet done much toward making the farmer more careful in his purchase of seeds.

CONCLUSION.

The foregoing is a brief and imperfect statement of some of the results accomplished by the stations in their efforts to meet the agricultural needs and improve the agricultural practice of the country. Enough has been said, it is believed, to show that the stations have abundantly demonstrated the wisdom of their establishment and maintenance on a liberal basis. They deserve the confidence and cordial support which they are winning in large measure from the

farmers of the land. With the encouragement of such support and the active cooperation of the farmers their power for usefulness must rapidly increase.

Regarding the cooperation of farmers with the Illinois station in corn breeding experiments (see p. 597), and of prominent stockmen with the Iowa station in experiments in fattening cattle for the market on a large scale, a writer in one of the leading agricultural journals[a] says:

A significant sign of the times is the growing disposition among farmers and stockmen to cooperate with the agricultural experiment stations of their respective States. In this union of forces there is great strength. In no other way can the stations so effectively serve the people for whose benefit they were organized. Moreover, the assistance of farmers in conducting experiments to solve feeding and breeding problems has the desirable tendency of making the results obtained more practical and hence more acceptable among laymen. Until within recent years there has existed between the experiment stations and the farmers a chasm which in large measure precluded mutual aid. Station bulletins, burdened with scientific minutiæ and technical data, from which but few unscientific readers could make practical deductions, did much toward establishing the pardonable attitude of those who regarded experimental work chiefly as an occupation for theoretical professors. Prejudice against the abandonment of old, traditional methods also stood in the way of closer relationship between institutions and those at whose expense they exist. It was natural that the initial work of the stations should be characterized by a few shortcomings, just as newly invented machines usually fail of perfect operation, but if proper consideration of this fact had been given, there would not have so long remained that indifference to the development of the stations which in recent years has rapidly been disappearing.

To-day the experiment stations and farmers are on substantial terms of reciprocal helpfulness, and the work of the former has been so intimately concerned in late years with the practical affairs of the latter that credence in agricultural investigational work has been greatly stimulated and the spirit of cooperation aroused to splendid activity. It has become clear to farmers who have sought improvement of their conditions through the larger use of brains that the land-grant colleges and experiment stations are zealously striving to advance agriculture and allied arts in every possible manner.

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[a] Breeders' Gazette, 42 (1902), No. 15, p. 643.

CULTIVATION AND FERTILIZATION OF PEACH ORCHARDS.

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Pathologist in Charge of Investigations of Diseases of Orchard Fruits, Bureau of Plant Industry.

Preparation of the Land for Orchards.

Commercial peach orchards in the United States have been planted out under all sorts of conditions. Very frequently the land is cleared of its timber during the winter and roughly broken up and planted at once to peaches. Even the peach orchardists who are doing this, however, will almost invariably admit that they prefer well-cleared and well-cultivated land. Wherever possible this should be secured. The great peach orchards of Georgia are mainly located on old, well-worn cotton plantations, although in the north of Georgia, in the mountain peach belt, new land is being freely used. The best method, where time is not too limited, is to cultivate the land in corn or cotton or some other crop suitable to the locality for two or three years before planting out the peaches. This is done to take the excess of nitrogen and general rawness out of the soil. Old, worn-out land, however, had better be sown to clover, cowpeas, or some cover crop, and this plowed under the year before planting. Any method adapted to the locality which will bring the land into good tilth is desirable. If the land is extra rich, cropping with an exhaustive crop like corn is good, but if it is poor, like most of the land best suited to peach culture, the method of plowing under clover, cowpeas, or some green manure is the better practice. Where feasible, it is better to grow potatoes or some truck crop, especially if the latter requires manuring and fertilizing, and thus bring the land into a garden condition. Most soils require deepening in order to grow peaches and other fruits to best advantage. It is a wise plan where poor land is being made fertile by plowing under clover or other cover crops, to plow the land an inch deeper than the natural depth of the soil each year for two or three years. By this means the surface soil can gradually be deepened. Subsoiling is undoubtedly of great benefit in preparing land for planting peaches. While the soil can only be plowed to a certain depth, the subsoil plow can be run 6, 8, or 10 inches deeper, simply loosening the subsoil without throwing it to the surface. In preparing land for planting out peaches the

tillage should be as deep and thorough as possible, for the reason that after the trees are planted and when they are growing there will be no opportunity for deep plowing. Any wet spots or poorly drained areas in the peach orchard should be looked after and thoroughly underdrained. While it might be unwise to plant peaches on areas requiring underdrainage, there is frequently a small corner or pocket in an orchard that it would not be profitable to work around which might be brought into condition for planting by drainage.

PLANTING ON OLD PEACH LAND.

One of the problems which confronts the peach growers in the older sections is the question of planting peaches on land that has previously been in peach orchards. There is no doubt that new land which has never been in peaches is distinctly better than land where peach orchards have been pulled out, and some growers advise not to plant at all on old peach land. However, the writer has seen some very successful orchards on land that had formerly been in peaches. The best method, however, is not to replant at once, but to pull out the trees by the roots and crop the land for two or three years at least before again setting out peaches. If the land is poor it is desirable to use the methods previously mentioned in preparing the land, giving special attention to the plowing under of cover crops and green manures and to deep plowing and subsoiling. One of the disadvantages of replanting peach orchards is in the parasites which remain over in the soil, such as root aphis, root-rot fungi, nematodes, and doubtless other unknown pests. An interval between the plantings will give an opportunity for the parasites to starve out or die out. Of course, the question of soil fertility is also important, but this is less serious, as it can be remedied by the application of manures and fertilizers. Where a peach orchard has been pulled out because of the yellows, there is usually less trouble in replanting than where the orchard has lived to maturity and the trees have died of old age. In case of root rot and nematodes the replanting is almost certain to be a failure, as these parasites live over in the ground and attack the young trees. Thrifty, mature peach trees frequently carry on their roots large numbers of root aphides and other root parasites without becoming seriously affected. However, when these large trees are pulled out and small young trees are planted on the same space, the number of roots available for the parasites to feed upon is so much reduced that trouble ensues. Young peach trees planted on old peach land should always be heavily fertilized in order to stimulate them to push growth vigorously and rapidly, so as to outgrow the parasites. A good plan, especially in the Northern States, is to dig the holes in the fall considerably larger than required for the trees, and fill them full of stable manure. Then in the early spring, fork out the stable manure and plant the tree in the enriched

FIG. 1.—CORNER OF A BLOCK IN HALE'S ORCHARD, FORT VALLEY, GA., WITH PEACH PACKING HOUSE IN THE DISTANCE.

FIG. 2.—PLANTATION OF HALE'S ORCHARD, FORT VALLEY, GA., SHOWING A PORTION OF THE ORCHARD OF 365,000 PEACH TREES.

FIG. 1.—BLOCK OF 7-YEAR-OLD ELBERTA PEACHES IN ROLAND MORRILL'S ORCHARD, BENTON HARBOR, MICH.

FIG. 2.—BLOCK OF 3-YEAR-OLD PEACHES IN ROLAND MORRILL'S ORCHARD, BENTON HARBOR, MICH.

[Photographed in September.]

ground, leaving the remnants of the manure in the immediate vicinity of the tree. It is certainly more difficult to secure a good stand and a uniform, thrifty growth on old peach land, but by giving extra care good results can frequently be secured. Wherever there is plenty of new land available, the old land had better not be used.

DISTANCES FOR PLANTING ORCHARDS.

The standard distance for planting the peach is 20 by 20 feet. Peach trees are very rarely planted any farther apart than this. The distance, however, varies greatly in different parts of the country on account of the soil, climate, and other conditions, and it also varies with the individual planter. In the Northern sections 18 by 18 feet is frequently used, and as one goes eastward the tendency is to shorten the distance to 15 by 15, and some growers, notably Mr. J. H. Hale, even advocate the planting of trees as close as 13 by 13 feet. (Pl. LXXXII.) Distances under 16 feet square are suitable for the growth of the young orchard up to perhaps about four or five years, and where the greatest yield per acre is desired of the first few crops these close distances answer very well. After the trees reach bearing age they very shortly begin to crowd at these close distances, and it is very doubtful whether ultimate results are as good as where a distance of at least 20 by 20 feet is used. In fact, in looking through some of the finest of the young peach orchards of Michigan, the writer has noticed that trees only seven or eight years old have completely filled the space of 20 by 20 feet and are already so crowded that they are not giving the best results. (Pl. LXXXIII, fig. 1.) In this sort of orchard it seems that 25 by 25 feet would be required. However, in many sections of the country peach yellows and other diseases are expected to kill out the young orchards, and the peach is looked upon as a short-lived tree, so that the planter feels safer in getting a crop from the young orchard than from his older trees. The result is that the whole policy is made to fit the young orchard rather than the mature orchard. (Pl. LXXXIII, fig. 2.)

THE RECTANGULAR SYSTEM OF PLANTING.

Undoubtedly, if the orchard is to be planted close, a better way is to plant on the rectangular system, rather than the square, and provide for taking out every other row of trees when they become crowded. This has been designated the filler system of planting. For instance, instead of planting 13 by 13, plant 12 by 16 feet, and then when the orchard becomes crowded take out the 12-foot row, leaving the trees 16 by 24 feet apart. In this way more or less of the advantages of both the close planting and the wide planting can be secured. The filler system is not so great a success with the peach as it is with the apple, pear, and some other fruits, for the reason that

the peach grows so rapidly and reaches maturity in such a few years that it seems hardly worth while to plant fillers for so short a time. The fillers will probably begin to crowd at four to five years of age. From the financial point of view, however, it frequently happens that a three or four year old orchard will bear a bushel or more of fruit per tree, and the net returns from one crop may be sufficient to more than pay for the entire cost of the orchard, including the land, and leave a handsome profit besides.

The rectangular system of planting is also a rather convenient method of planting out the orchard, regardless of the filler system, although it is particularly suitable to the requirements of the latter. The writer is planting out a peach orchard on a rather good piece of land 18 by 24 feet apart, leaving the trees, therefore, 6 feet wider one way than the other. This gives a better opportunity for spraying, plowing, cultivating, and hauling out the fruit. The rectangular orchards are particularly more convenient in spraying. The tendency of mature peach orchards is to form a complete canopy of twigs and branches, so that there is little opportunity to get between or around them. In some cases, however, the rectangular system is carried to an extreme; for instance, rows 24 to 30 or even 40 feet apart, and trees planted from 10 to 14 feet in the row. This, of course, makes a rather queer-looking orchard, and of an undesirable form. The object of the grower usually is to utilize the space between the trees, but such unreasonable distances are beyond the capacity of the tree to fully occupy. In the case of a moderate rectangle, such as 16 by 24 feet, there is no good reason why the trees can not properly adjust themselves to this space just as well as to a space 18 by 18, or a circle 18 feet in diameter. The peach tree is a voracious feeder and a vigorous grower in both root and top; the roots will find every available space of unoccupied soil and will utilize it to the best of their ability.

THE CONTOUR SYSTEM.

On steep hillsides and mountain sides, where the soil is likely to be washed by heavy rains and where it is difficult, frequently, to plow or cultivate the orchard up and down the hills, peach orchards should be planted out on the contour system, that is, the lines of peach trees should be laid out on contour lines, or lines of equal level, running around the hill.

In this case it is unwise to adopt any definite distance, but the endeavor should be to give each tree approximately the equivalent of, say, 20 by 20 feet. The contour lines need not be followed with absolute accuracy where the land is very uneven; otherwise the irregularities in the orchard will be a little too great to be overcome. Where the slope is fairly even, however, it is advisable to lay the contours accurately. About 20 to 24 feet is a proper distance for placing the contour rows apart, and about 18 to 20 feet will do for the distance between the trees. As the contour lines approach each other, and the

space becomes narrower, the distance between the trees may be increased; and where the contours are separated by the nature of the slope from 25 to 30 feet they may be placed at a shorter distance. In case the lines separate to 35 or 40 feet, a short additional row may be inserted in the best manner to utilize this space.

METHODS OF PLANTING IN DIFFERENT SECTIONS.

The method of planting out the orchards varies greatly in different parts of the country and with different orchardists. The writer's preferences as to planting out are either the stake method or, on a very level piece of ground, simply laying off the land in furrows. The stake method has been fully described in a previous article on "Commercial pear culture" in the Yearbook for 1900. The furrow method is only applicable to level land, and where a careful man can be secured to lay out the rows. In many horticultural text-books and papers there are very carefully described methods of planting with a notched board and other similar methods. Such practices have no place in the work of a commercial orchardist. With a little practice and a proper method, especially with the stake method, men can plant out the trees rapidly and accurately, and the labor would only be doubled by introducing the notched board. In the Southern States, notably in Georgia and Florida, the large growers have used for several years a very simple method of planting by spade. The land is very carefully prepared and the trees are trimmed to a straight cane, and the branches and roots cut to within an inch of the main root. One man thrusts down the spade and moves it back and forth until a sufficient hole is made to insert the closely-trimmed tree. The spade is withdrawn, the tree inserted, and the spade thrust beside the previous opening, forcing the dirt over against the tree. Trampling with the feet finishes the operation. Two men, by this method, can plant out more than a thousand trees per day. Such close trimming is not advisable with large trees, and is probably not advisable in more northern States, where spring comes on rapidly and where the demand on the roots is rather sudden and intense. On the light soils and under the climatic conditions of the Gulf States, root growth proceeds during the winter, and when spring causes the buds to push forth, the roots are ready to supply them with moisture. This method has been taken up in Texas and widely discussed by Mr. Stringfellow, and in its most intense form has been called the Stringfellow method. The discussion of the Stringfellow method in recent years may be summed up about as follows: With small trees and in the warm soils of the Gulf Coast States the close-pruning method is successful and has been extensively used for years. In the Northern States, and especially in the heavier soils, it is not a desirable method.

In planting out it should be remembered that in very light soils the peach can be set deeper than on heavy soils. The peach is a

shallow-rooted tree, and as a general rule should be planted rather shallow. However, many mistakes have been made in getting the peach tree planted too shallow, especially on hillsides and mountain slopes where some of the soil is washed away. The disadvantages of the too shallow planting of the peach are two. In the first place, if the trees are attacked by borers, the borers on shallow-planted trees are apt to get down between the roots and even sometimes under the main roots, where they can not be reached. In the second place, a very slight amount of washing of the surface soil soon exposes the roots and the collar of the tree to a dangerous extent. It is usually advisable to have the main roots of the tree at least 6 to 8 inches below the general level of the soil at the time it is planted. This will generally put the union of the body with the stock a couple of inches below the surface of the soil. On light soils, and in the Gulf States on both light and heavy soils, there is little to be feared in getting the peach tree 2 or 3 inches deeper than it stood in the nursery. In the extreme Southern States, and especially in Texas, the peach tree does not stand deep planting so well. For some reason, under the conditions there, possibly the extreme heat of summer, or perhaps the mildness of the winters, the tree does not do well when the earth is piled up too deeply around the collar or when the young tree is planted too deeply below the surface of the soil. In regard to aëration, the peach roots seem to require more air and better access to the air than any of the fruit trees, or, perhaps, than almost any other tree. They are very sensitive to smothering, either by heavy soil or by water, and this tendency seems to reach its extreme in Texas and other Gulf States.

Cultivation of the Orchard.

A grower in the mountain peach region of Maryland sows wheat in his orchard the first year and seeds down to common red clover in the wheat, giving no cultivation whatever the first season. The second season he plows two furrows with a one-horse plow around the trees, cultivates three or four times with a one-horse cultivator, and mows the clover for hay, and even in a favorable season saves a crop of clover seed as a second crop. The third year he plows three furrows instead of two around the tree rows and pastures the clover with hogs. This may be stated as an extreme case of noncultivation of the peach. The man who carries out this practice does it intelligently, apparently realizing fully that it is an unusual practice, and yet it shows financial returns to justify him in the process. On the other hand, in other sections of the country nothing whatever is planted in the orchard even the first and second year. Absolutely clean cultivation is given during the growing season, the cultivators and harrows being kept running, so that not even a weed is allowed to grow.

Between these two extremes there are all sorts of variations. (Pls. LXXXIV and LXXXV.) It is certain that the noncultivation method

FIG. 1.—LARGE BLOCK OF YOUNG PEACH TREES IN NURSERY OF HALE'S ORCHARD, FORT VALLEY, GA.

[Photographed in August.]

FIG. 2.—BLOCK OF EMMA PEACHES IN SAMUEL H. RUMPF'S ORCHARD AT MARSHALLVILLE, GA.

FIG. 1.—VIEW OF FRANK G. CARPENTER'S PEACH ORCHARD IN THE MOUNTAINS OF VIRGINIA, WITH CREST OF THE BLUE RIDGE IN THE DISTANCE.

FIG. 2.—THREE-YEAR-OLD PEACH ORCHARD OF FRANK G. CARPENTER, SHOWING THRIFTY TREES WITH LITTLE CULTIVATION.

[From photographs taken in October.]

can only succeed in particularly favored sections of the country, and even in these favored localities, where the soil is deep and moist, yet well aërated, it is extremely doubtful whether at least moderate cultivation would not be profitable and yield better results than non-cultivation. No tree is more sensitive to good cultivation than the peach. It requires more cultivation, better aëration of the soil, and a lighter, looser condition of the surface soil than any other fruit tree. Some of the best peach orchardists, and especially some of the best writers on horticulture, advocate the giving up of the entire ground in the peach orchard to the culture of the trees. They will grow no crop whatever among the young trees except cover crops. On the other hand, most practical peach growers advise the use of some crop for profit between the trees. In considering the question of the cultivation of the peach tree the orchard will be divided into two periods, first the cultivation of the young orchard, and second the cultivation of the bearing orchard.

CULTIVATION OF THE YOUNG ORCHARD.

In the cultivation of the young orchard it is advisable to grow some crop for profit among the trees. This need not necessarily be injurious to the orchard if the crop be properly selected. In fact, with the proper type of crop for interculture and the proper use of fertilizers on poor soils the orchard may be actually benefited by the crop which becomes a nurse crop. As a rule, grasses and grains are the most undesirable crops to grow in the orchard. Wheat, oats, and rye are particularly objectionable, for the reason that they prevent the cultivation of the soil during the critical growing season of the peach trees; they also occupy every available inch of soil space, and their draft on the soil moisture is very severe. Grass is still more objectionable than the cereal crops, because with it the ground is not even plowed annually. Even the clovers, which get part of their nitrogen from the air and add to the fertility of the soil, are objectionable on account of preventing cultivation. Indian corn is very commonly grown in peach orchards the first and second years (Pl. LXXXV, fig. 1), and on very rich, moist soils it is, perhaps, not especially objectionable. The disadvantage of indian corn is its heavy draft on the fertility of the soil, and especially its tall-growing qualities. During the early part of the summer it is not objectionable, but from midsummer on it completely overshadows the young trees. However, it somewhat protects the young orchard and seems to have no objectionable features except its exhaustion of the soil. The cultivation of the corn crop is about the same cultivation that the young orchard needs, except that it frequently does not continue late enough in the season. Most soils, however, that are well adapted to peach culture are not rich enough to stand the heavy draft of the corn crop, and as a rule corn culture in the orchard is to be

condemned on this account. Cotton is less objectionable than corn. (Pl. LXXXVI, fig. 1.) It seems to grow with the peach orchard very well, and is used extensively in the Southern States from Georgia to Texas. It has not quite the exhaustive power of corn, and seems to be equally favorable to the growth of the peach tree. Cantaloupes and watermelons are used quite extensively as an orchard nurse crop. Where the melons are properly fertilized they do not exhaust the soil and are an excellent crop for the orchard. This applies especially to the Middle and Northern States, where the melons are grown rather late in the season. In Georgia and the other Southern States cantaloupes are extensively grown in the peach orchards, but are somewhat objectionable, principally, no doubt, from the fact that they are planted as early in the season as possible, and the growth of vines prevents cultivation very early in the spring before the peach trees are through with vigorous growth. Watermelons, squashes, and other cucurbits are also grown occasionally in the orchard and with fairly good results. In New York State late cabbage is a very popular crop to grow in the peach orchard. (Pl. LXXXVI, fig. 2.) It is a very excellent crop for the orchard, the land being usually manured and fertilized to some extent. Its cultivation corresponds to the period of cultivation of the peach trees. Other vegetables, such as beets, onions, radishes, and miscellaneous vegetable crops, are occasionally used, but not on such a large scale. No crop has more advantages for cultivation in the Northern States, such as New York and Michigan, than beans. The ordinary navy bean is grown quite extensively in the peach orchards and has everything to commend it. It is not planted early, giving time for several harrowings or cultivation of the orchard before the seed is even put in. It is low growing and not very exhaustive. It gathers a large part of its own nitrogen. It calls for clean culture and requires very little disturbing of the soil at harvest time.

In Virginia peanuts are occasionally grown in peach orchards in the lower country, while garden peas are frequently seen in various parts of the State. Both of these are desirable crops for the orchard. In the Middle States tomatoes are a very popular crop for cultivation in the orchards; they are not objectionable, especially when they are grown late, and their cultivation is continued until midsummer. One advantage of the tomato crop is the fact that crimson clover can be sown at the last cultivation of the tomatoes and a cover crop grown as well as a nurse crop. Potatoes are grown occasionally in the peach orchard, but have been condemned by many peach growers. The reason seems to be that the roots of the Irish potato interfere with the peach, or, perhaps, the stirring of the ground at the digging time is injurious. Potatoes are usually dug with a plow or a potato digger, and the disturbing of the soil in the fall is supposed to be unfavorable, as it cuts a good many roots of the peach tree, injures

others, and probably stimulates development of roots at the wrong time. However, the writer is informed by several Michigan growers that if potatoes are grown in the orchard and dug with a fork late in the season there is no noticeable injury. Sweet potatoes are also a very good crop for cultivation in the orchard. Their principal growth of vine is late in the season, after the orchard has had abundant opportunity to make its annual growth. The quantity of manure and fertilizer which is applied is usually very large, and the trees are especially benefited by it. In digging sweet potatoes early there would probably be the same objection as in the case of the Irish potatoes, although the writer has never heard the point raised by a peach grower; but the digging of sweet potatoes late in the season, about the time of or after the first frost, would probably cause no injury. At any rate, that has been the writer's experience with this crop. Strawberries are one of the undesirable crops to grow in the peach orchard, for the reason that they prevent the proper plowing and stirring of the soil at critical periods. Other small fruits, such as the bush fruits—raspberries, blackberries, currants, etc.—are still more objectionable in the peach orchard. While small fruits and berries may be occasionally grown in orchards of apple and pear with good results, especially if the land is deep, rich, and moist, it is not desirable to attempt the culture of these fruits in the peach orchard. The peach is too gross a feeder to withstand the competition of such perennial plants, and will either suffer itself or greatly diminish the vigor of the small fruits.

In the use of nurse crops and other crops in the peach orchard it is not advisable to continue the cultivation after the second season. Occasionally cotton is grown between the trees the third and fourth year, but it is usually a very light crop of cotton; it is doubtful, if the trees have made a good growth the first and second years, whether anything should be attempted the third year. In fact, the peach tree itself is so vigorous that usually attempts to grow other crops after the third year end in failure. Crops which are grown in the orchard for profit and yet cultivated for the benefit of the orchard may be called nurse crops. The term "nurse crops" could hardly be used for those crops which are grown solely for profit and not for the benefit of the orchard, such as indian corn or cereals; but such crops as the hoed crops, potatoes, beans, peas, etc., especially when they are fertilized and given high cultivation, are properly designated as nurse crops.

Cover Crops.

Another class of crops is grown in the orchard, namely, those grown entirely for the benefit of the orchard soil, and as these are usually left on the ground and serve as a winter protection for the soil, they have been commonly called cover crops. These cover crops are of two main types, leguminous and nonleguminous. They may be also divided into two other classes, namely, those which are winter annuals

or perennials, remaining green over winter and therefore furnishing a living cover, and those which, either from their tenderness or from their annual character, die down at the end of the year and furnish only a dead covering during the cold months.

CRIMSON CLOVER AND HAIRY VETCH.

Under conditions of high culture and where it is adapted to the locality, crimson clover is undoubtedly the nearest to an ideal cover crop. (Pl. LXXXVII, fig. 1.) In the Middle States crimson clover may be sown at the last cultivation of the peach orchard in August, or even September, and it will make a good growth, covering the ground before cold weather, by which time it frequently attains a height of from 6 to 8 inches. It forms a very large root growth during the autumn, and only ceases growing during the coldest winter weather. When the mild weather of early spring approaches it starts into activity; by the time the peaches are in blossom it is growing vigorously and a few days later comes into bloom. The very best results are secured by plowing the clover under early, before it has come into blossom, although by so doing a part of the fertilizing value of the clover is sacrificed. However, the enormous root system is of great benefit, and the thick coating of stems and leaves furnishes an excellent green manure. It is often desirable in the young orchard to plow three or four furrows around the trees at an early date, about the blooming time or slightly before the blooming time of trees, and then allow the clover to head out before plowing out the middles. By this means the greatest possible amount of fertilizing value is secured.

Hairy vetch (*Vicia villosa*) is about the only real rival to crimson clover. It makes a very rank growth in the fall, and has been found by some to be easier to seed and to be even more successful than crimson clover. However, the seed is more expensive and harder to save, and it is doubtful, where crimson clover will survive the winter and prosper, whether hairy vetch will ever drive it out of use. The common red clover, either the medium or the mammoth, can be used in the same way as crimson clover. By seeding it late in July or in August it will form a good cover before cold weather. It has the advantage of being more hardy than crimson clover and starts later in the spring. Its use is gaining ground distinctly every year in New York State and Michigan. There is one trouble with both these clovers, and that is the temptation to let them remain too long before plowing in order to obtain the greatest possible results, but the experience of practical growers is that it is better to plow them under when the proper time for plowing arrives, or very shortly after, regardless of the growth the clover has made. If a dry spring comes on and clover is allowed to remain until it comes into blossom it draws too heavily on the moisture content of the soil. Even though thoroughly cut down with a disk harrow the surface soil is so dry that the effect on the trees is unfavorable.

FIG. 1.—COTTON GROWING IN A 3-YEAR-OLD PEACH ORCHARD AT SAMUEL H. RUMPF'S PLACE, MARSHALLVILLE, GA

[Photographed in November.]

FIG. 2.—CABBAGE GROWING IN A 2-YEAR-OLD PEACH ORCHARD IN WESTERN NEW YORK.

[Photographed in September.]

FIG. 1.—A NIAGARA COUNTY, N. Y., PEACH ORCHARD, SHOWING CRIMSON CLOVER AS A COVER CROP.

[Photographed in September.]

FIG. 2.—COWPEAS GROWN AS A COVER CROP IN HALE'S YOUNG ORCHARD, FORT VALLEY, GA.

[Photographed in August.]

COWPEAS, VELVET BEANS, ETC.

Of the leguminous cover crops, which do not survive the winter, the cowpea is undoubtedly the most important one for use in the peach orchard. (Pl. LXXXVII, fig. 2.) It is extensively grown all through the Southern States and even as far north as southern New York and Michigan. It is essentially a hot-weather plant and should not be sown until late corn planting. Its principal advantage is in the young peach orchard, where it should be sown in drills from 2½ to 4 feet apart and kept cultivated during the season. It is advisable generally to allow a greater space for the tree row. Frequently the cowpea is grown in drills in a three-year and four-year old orchard after the abandonment of the growth of nurse crops. In Georgia the writer has seen in a good peach orchard one row of corn in the middle and a row of cowpeas each side of the corn. When the corn matures it is cut and removed and the cowpeas are allowed to cover the entire ground. One advantage of cowpeas in Southern peach orchards is that they may be sown quite late in the season. Occasionally, however, in a dry, cool summer the results from late sowings are not all that could be desired. It is a debatable question whether cowpeas should be plowed under while still green or left on the ground to decay. The experience of the best fruit growers is that cowpeas should not be plowed under in the peach orchard while they are still green, but that they should always be dead and somewhat decayed. There is no objection to plowing them under during the winter, but as a general rule it is better, in the North, to wait at least until after the frost has killed them, or, in the South, until they have died naturally; or perhaps it may be preferable to leave them on the ground during the winter and plow them under in the spring. The greater part of the value of the cowpea vines will then have leached out into the soil, and the soil will plow up in excellent mechanical condition as the result of the protection of the vines.

The velvet bean is grown to some extent in south Georgia and the other Gulf States in peach orchards, and within its natural range, which only reaches about 150 miles from the Gulf, it exceeds the cowpea in growth of vines and in quantity of fertilizing material. It grows the whole season through, and consequently has more opportunity for putting on vegetative material than the pea vines, which reach their full growth and die from maturity before the close of the season. One objection to the velvet bean is that it climbs all over the trees and forms a tangle of vines which is more or less troublesome to remove. Another objection is that it can only be plowed under by efficient sulky plows, which are not very convenient to use in the orchard. One way to handle the vines, however, is to cut them to pieces by driving over them several times with a disk harrow before attempting to plow. North of the belt adapted to the velvet bean the plant is not satisfactory as a cover crop, for the reason that it does

not reach its full maturity and the hot weather does not last long enough. The soy bean has even a greater range northward than the cowpea, but it does not seem to be quite as well adapted to the purposes of a cover crop as the cowpea. It is more upright in growth and more convenient to cut for hay, but this upright growth is rather objectionable in a cover crop, as the ground is left more or less exposed between the plants when the leaves have fallen.

NONLEGUMINOUS COVER CROPS.

Of the nonleguminous cover crops, in Michigan and New York State, oats are very commonly sown in the orchard at the last cultivation. They are either sown broadcast and harrowed in or else put in with a disk or other form of grain drill. The oats are generally planted about the first of September, and before cold weather they have reached 5 or 6 inches in height. They serve not only to prevent the sandy soil from blowing away, but prevent washing, and catch the leaves of the peach trees when they fall to the ground. The oats used in the Northern States are commonly the ordinary spring varieties grown in the neighborhood, which kill down on the approach of winter. (Pl. LXXXIII, fig. 2.) This cover crop, therefore, is a dead one, and it interferes but little with plowing the following spring. Winter oats are sometimes used in the Middle States, and it seems to the writer they would be superior to the Northern oats in the peach orchards of the Lake region. These winter oats are hardy strains and, like rye and winter wheat, survive Southern winter weather. Rye is also grown extensively as a cover crop in the orchard. It has been objected to by some growers, on account of the fact that if plowing is delayed in the spring rye makes a very rank growth and draws the moisture from the soil to the detriment of the tree; but if rye is plowed under when it is just shooting up its flower stems, this objection, of course, does not obtain. Dwarf essex rape, cowhorn turnips, buckwheat, and even indian corn are frequently sown in midsummer or later as cover crops in the orchard.

The nonleguminous cover crops, while theoretically of not much value, in actual practice turn out to be very useful. While they are not as valuable as the crimson clover and other leguminous crops in gathering free nitrogen from the air, still they do gather a large quantity of nitrogen from the soil which would otherwise leach away; they also make a large amount of humus or organic matter and serve an excellent purpose in improving the mechanical condition of the soil. They are usually easier to sow and cheaper to grow and handle than the leguminous crops, and where soils are not notably deficient in nitrogen are frequently the best to use. It is not so easy to grow cover crops in the peach orchard successfully as in the pear or apple orchard, for two reasons: First, the peach trees, as soon as they attain bearing size, are very vigorous feeders and are very shallow

rooting trees, so that it is difficult to get a good growth of anything among them; this does not apply as much to the late fall leguminous cover crops as to those grown earlier in the season, and is not so important in the far South, where the late fall allows cowpeas and velvet beans to grow after the trees have reached maturity. Second, the peach tree so imperatively demands cultivation from about the blossoming time until nearly the ripening time of the fruit that there is little opportunity to grow any heat-loving cover crop in the peach orchard; in the young orchard before the roots have occupied the soil and the top has shaded the ground the growth of summer cover crops is not so difficult.

CULTIVATION OF THE BEARING ORCHARD.

The annual practice in cultivating the bearing orchard will now be described. There are some who maintain that the ordinary turning plow should never be used in the orchard, and who advocate the use of disk harrows and spring-tooth and other cultivators as the sole implements. However right this may appear theoretically, in actual practice most peach orchardists have found it necessary to use the plow, and it is very doubtful whether the much-abused turning plow is so objectionable after all. Whenever there is a large quantity of weeds or trash or a successful cover crop or turf to turn under, the ordinary turning plow is by all odds the most important implement that can be used. Where the ground has had clean culture the year before and no cover crop has been used, any of the various types of disks or cutaway disks can be used to put the ground into practically the same condition as the plow. The advantage of the disk over the plow is that the feeding roots are not cut off clean at any definite depth, but that many of them which would be cut with the turning plow at a given depth may survive. If the disk-harrow method of plowing is used it is advisable to go over the orchard once or twice each way and then follow with a spring-tooth harrow. If the soil is light, and if the operation is begun when the soil is first in condition after being lightened and softened by winter freezing, excellent results may be secured. Some large orchardists depend entirely on disk harrows to cultivate the bearing orchards. However, the majority of the growers plow the orchard first with the turning plow. A good practice is to plow two or three furrows around the trees with a one-horse plow so arranged as not to injure the trees, either by adjustment of a side-block with the clevis or by having a very short singletree and wrapping the traces with burlap to prevent scarring the bodies of the trees. After about three furrows have been made with a one-horse plow, a two-horse or even a three-horse plow can be used to plow out the middles. A very excellent tool for plowing the first three furrows around the trees is the so-called California orchard plow. This plow, made in two sizes, with either three or five disks,

with a good team of horses, performs the whole operation at one trip. Great pains should be taken in plowing the first strip around the trees to keep from injuring them and to avoid tearing up the roots. A skillful plowman will discover at once whether the plow is catching on the roots, and will throw it out of the ground or slightly to one side just as he passes the trees. A very ingenious though simple modification of the common plow is in use in Georgia orchards. A pole 9 feet long, with a slight crook about 2 feet from the end, is fastened into the plow as a substitute for the handles. This pole extends outward from the plow at an angle of about 30 degrees, enabling the plowman to walk alongside the trees and pull the plow to one side just at the instant the tree is passed.

There are special plows, called vineyard and nursery plows, which have a wide range of adjustment and can be swung to one side or the other of the line over which the horse is driven. These are very convenient, especially in plowing away from the trees. Various modifications of the harness are in use to prevent injuring the trees, and several forms of two-horse traceless harness have been designed to enable a span of horses to be driven quite close to the trees without injury. As a rule, the peach orchards should be plowed very shallow, not over 3 or 4 inches, and frequently this will be considered too deep. The writer's idea is that by beginning fairly deep plowing on the young orchard a greater depth of plowing can be done in later years than is commonly practiced. By plowing 4 inches next the trees and 6 inches in the middles while the orchard is young a depth of 3 inches close to the tree and from 4 to 5 inches in the middles can be maintained in the older orchards, resulting in a deeper soil for the trees to grow in. Plowing always cuts more or less of the tree roots when done to the depth of even 3 or 4 inches, but as a rule these small roots are only annual roots of the year before and can be readily spared, being quickly replaced by the tree. Moderately deep plowing is doubtless of more benefit than harm. After the soil has been plowed toward the trees a rather deep dead furrow results. Sometimes it is advisable to turn this in with a one-horse plow by making two trips around it. Usually, however, the best practice is to begin promptly with the spring-tooth cultivator and with the teeth set so deeply that they go to the full depth of the soil as turned by the plow.

It is usually best to alternate the different types of harrows, and wherever a cover crop, especially clover, is turned under, the disk harrow is more effective than the spike-tooth or spring-tooth, as it cuts the turf and vegetable matter to better advantage. However, if the soil has been pounded down quite hard by rain, even without a cover crop in it, the disk harrow is more like a plow in its action in turning it up. After the disk or the cutaway, if a dry spell comes on, the acme or the ordinary spike-tooth can be used to good advantage in smoothing and fining the surface and perfecting the dust mulch. If dry

weather still continues the acme can be followed by the weeder, and even when a very light rain forms a slight crust the weeder can be used to good advantage. As cultivation proceeds in the summer, it should be lighter and shallower, depending mainly on the spike-tooth and the weeder unless very heavy pounding rains come; then the disk or the spring-tooth harrow may be required to lighten up the soil.

Many peach-orchard soils are so rocky and stony that the disk harrow can not be used. As a rule, the spring-tooth harrow is found to be best in such situations. The question of how late to cultivate is much debated among growers and the practice varies in different parts of the country. As a rule, the more thoughtful and careful the peach grower, the greater the number of times he cultivates. Taking into account the use of the weeder as well as the plowing and harrowing, it is not rare that the orchard is gone over 20 or 30 times in a single season, and, in fact, some of the best cultivated orchards are gone over once or twice a week until the close of summer. Frequently a heavy load of fruit prevents cultivation for some time before picking. The weight of the fruit bends down the branches so that the peaches may be knocked off by the team, or in extreme cases so that a horse can not be driven through the orchard. In Georgia and other Southern commercial orchards it is usually impracticable to cultviate when the picking season begins, for the reason that every available man and horse is pressed into service to handle the fruit, but in new plantations or where there is a failure to fruit, and full opportunity is given, cultivation should proceed right along until the middle of August or even into September. In the Northern States, where the main varieties of peaches do not begin to ripen until the latter part of August, cultivation normally can continue up to that time, after which it is not desirable to force the trees into heavy growth; but they should have an opportunity to ripen up and mature their wood. In some of the newer peach sections of the mountain region of Virginia, and notably in the orchards of Texas, the soil being very favorable and the natural conditions suitable to the peach, the minimum cultivation is given. Sometimes the only cultivation is two or three plowings with a one-horse turning plow. The weeds between the plowings grow so high that no other tool than a turning plow is suitable for the work. As a rule, however, such methods are not gaining ground, and those who pursue them are not the most successful growers of the peach. The tendency is more and more toward high cultivation, for the reason that the profits in fancy peaches as compared with poorly grown fruit are annually becoming better.

FERTILIZATION OF THE ORCHARD.

In connection with the use of fertilizers for the peach orchard the natural fertility of the soil is, of course, the first consideration.

In some Northern and Western States and in a portion of the mountain peach orchards from Pennsylvania and Maryland southward the soil naturally carries sufficient plant food to meet the demands of heavy crops of fruit. Of special importance in this regard is the subsoil. If the subsoil is deep and rich and well supplied with phosphoric acid and potash, trees are able to carry immense crops of fruit and still maintain a fairly vigorous condition. However, as a general rule, soils that are suited for peach growing are more or less deficient in the elements of fertility, and it is rare that maximum crops can be secured without to some degree supplying plant food artificially. In many of the orchards in the more fertile parts of the country but little mineral fertilizer is commonly added. The plowing under of green manures or, perhaps, the occasional application of suitable manure or wood ashes supplied from the farm are about the only fertilizers that are deemed necessary. But often in the more fertile sections the progressive fruit grower has found that while good crops may be secured by good cultivation without the use of fertilizers, still better crops of finer fruit can be secured by supplementing the natural fertility. In all the less fertile sections of the country, especially in the East and South, the fertilizer problem in the peach orchard is one of prime importance. The residual effect of manures and fertilizers used on nurse crops has already been mentioned in connection with cultivation. Nurse crops play an important part, and frequently, when well manured and fertilized, their cultivation for two or three years in the orchard has resulted in ample growth of the trees until a heavy crop of fruit is borne. In fact, the bearing of a heavy crop of small fruit and the subsequent impoverishment of the trees are frequently the first indications the grower receives that his trees are suffering from lack of fertility. It is better, however, not to allow the trees to suffer, but to anticipate the difficulty and fertilize or manure in advance.

Green manures and cover crops should be utilized to the fullest possible extent in the orchard. There are some soils so well supplied with humus that the annual use of green manures is not essential, or, perhaps, in some cases not even desirable, as the amount of humus and nitrogen might be unduly increased and an excessive or belated, immature growth of twigs and buds result. However, in most peach orchards, especially in the sandy and poorer soils, this condition is not to be feared, and annual cover crops should be plowed under. On a moderately rich soil perhaps all or nearly all the nitrogen necessary can be supplied with leguminous cover crops, but even here it is not always safe to depend entirely on the cover crops. Perhaps a dry year may come, with a heavy crop of fruit, and while an unusual draft is made by the trees on the nitrogen of the soil very little is returned to it; therefore the nitrogen should be replaced artificially.

Indirect fertilization, therefore, from nurse crops and from cover crops, combined with the natural fertility of the soil, can not be depended upon for maximum crops over most sections of the country. Direct fertilization may be necessary. In the young orchard, where the soil is very fertile, it may not be necessary to fertilize the young trees till they come into bearing.

On poor, sandy land about a third of a pound of fertilizer thrown immediately around the tree is desirable the first year. It should not be in actual contact with the tree, but should be scattered so as to cover a circle about 3 feet in diameter. The second year the fertilizer can be added after the first furrow has been plowed around the trees, and can be thrown in the furrows on each side of the tree. From a half pound to a pound is desirable at this stage, and should be strewn from a distance of 4 to 6 feet along the furrow. The third year at least a pound or more should be used, and it had best be applied in the second or third furrow from the tree in the same manner. Occasionally, on very light land, it is desirable to apply stable manure in the second or third furrow, as above described. The plowing of the next furrow completely covers the manure or fertilizer, which is thus placed in a good position to be reached by the roots. If the orchard is plowed and fertilized in an east-and-west direction the first year it will probably be desirable to plow north and south the second year, the fertilizer thus being distributed on all sides of the tree.

STABLE MANURE.

The use of stable manure in the peach orchard is a much-debated question. It should never be used on young orchards, except on very poor, light land, and then should always be applied in winter or early in the spring. On bearing orchards stable manure has much effect, stimulating the twig growth and leaf growth more or less at the expense of the fruit. If the soil is already moderately fertile it may distinctly overstimulate the vegetative tendencies of the tree. It has the same effect as other nitrogenous fertilizers in belating the fruit, with a tendency to prevent the high coloring of the product. The fruit is also rendered more liable to the attacks of peach-rot fungus. In extreme cases the effect is distinctly injurious to the general health of the tree, causing gummy exudations from the bark. This is very frequently seen around barnyards and where drainage water from barnyards settles around the trees. Trees are frequently killed outright during a cold winter following an excessive application of stable manure or other nitrogenous fertilizer. On the other hand, trees which have a pale, yellow color, and are suffering from lack of nitrogen on poor, light, droughty soils, are so far below the standard of vegetative growth that they need the stimulus of stable manure

to bring them up to the proper level. Here stable manure finds its proper application.

This form of manure is also beneficial in case of several diseases which have an effect similar to poverty of the soil, namely, root aphis and sour soil, and perhaps, also, root rot and some other root diseases. Trees suffering from root aphis and other root troubles are very apt to exhibit symptoms of starvation, and usually respond favorably to the application of stable manure. They can stand very much more manure and profit by it than a normal, healthy tree.

CHEMICAL FERTILIZERS.

As to chemical fertilizers, many old-time peach growers in the Northern States are positive that wood ashes and bone meal are the best fertilizers for the peach orchard. These materials are undoubtedly very excellent for the purpose, and it is very doubtful whether, all things considered, any of the more strictly chemical fertilizers can ever produce as uniformly good results. However, the effect of most experimenting has been to show that potash in the form of muriate or carbonate or sulphate is indistinguishable in efficiency from wood ashes, and the same is true of bone meal. The soluble acid phosphate, or acidulated bone, or bone charcoal, have about the same effect as the bone meal, except that they are more quickly available, on account of their increased solubility. At any rate, there is no doubt but that the peach responds very favorably to liberal applications of acid phosphate and muriate of potash, as well as to bone meal and ashes. A very good fertilizer for the peach on land fairly rich in nitrogen, or which is well supplied with nitrogen from leguminous cover crops or stable manure, is a mixture containing 1 part of muriate of potash to 3 parts of acid phosphate. This should analyze about 12 per cent actual potash and 10 per cent phosphoric acid. If a slower action of phosphoric acid is desired bone meal may be substituted for part of the phosphate. This will also increase the nitrogen to some extent in the combination. Bone meal supplies the soil with a very desirable form of nitrogen for the peach tree. If, however, a greater quantity of nitrogen is desired, as on very poor, light, sandy land, bone tankage may be used instead of bone meal or along with the bone meal, and nitrate of soda may be also added to the fertilizer. As a general rule, however, it is better to leave out the nitrate of soda and apply it later, when the leaves are pushing out in the spring. The standard mixture for the peach, consisting of potash, phosphoric acid, and insoluble forms of nitrogen, may be applied in the fall, or, in the Southern States, at any time during the winter. At any rate, if applied in the spring this mixture should be put in very early and preferably plowed under, or if the land is plowed very early it may be sown broadcast and harrowed in. Very good results are secured by

drilling with a grain drill which has a fertilizer attachment. The following formula may be considered a very excellent fertilizer for poor land, deficient in nitrogen:

10 to 12 per cent of potash from the muriate.
7 to 8 per cent of phosphoric acid from acid phosphate.
3 per cent of nitrogen from bone tankage and nitrate of soda.

An application of 400 to 600 pounds per acre should be considered the minimum where it is only desirable to use a little fertilizer to supplement the natural fertility. On poor, sandy lands, in which the fertilizer is looked upon as the main basis of the fruit production, 1,000 to 1,200 pounds is the proper amount to use. One important consideration should always be borne in mind by the peach grower in planning the fertilization of the orchard, and that is the intelligent use of nitrogen. As already stated, the peach tree is the most vigorous feeder and active grower of any of the fruit trees, and is the most sensitive and easily disturbed by nitrogenous fertilizers. While safer in the long run to withhold nitrogen and allow the trees to slightly suffer for lack of it, yet for best results it is necessary to give the trees just enough of this important ingredient. Barring diseases, nitrogen starvation is indicated by lack of size and color of the foliage, by a slender and weak growth of twigs, and a shortness of joints between the leaves. The annual growth of young trees from one to three years old with good cultivation should be at least 3 or 4 feet, and the foliage should be dark green in color. After three years of age, when the orchard comes into bearing, and up to twelve years, the annual growth should be at least 18 inches, and better, from 2 to 3 feet, especially if heading back is practiced. Anything less than this will indicate lack of nitrogen. On the other hand, too much nitrogen is indicated by a very rank growth of the trees, an unusually dark green color of the foliage, immaturity of the tips of the twigs at the close of the season, by late fruit, with lack of color and poor flavor, and in extreme cases by the gumming of the bodies of the trees without apparent cause. Trees will stand more nitrogen in a dry season than in a wet one. In a rainy year on rich soil the effect of excessive nitrogen seems to be increased by the heavy rainfall, and vice versa in a dry season. Good cultivation has an effect on the fruit and foliage similar to nitrogen fertilization, while lack of cultivation gives somewhat the same symptoms as nitrogen starvation. In both the young orchard and in the bearing orchard the skillful grower will watch his trees when they are pushing out into growth during the month following blooming, and on the bare, sandy knolls and impoverished places will give additional fertilizer—especially additional nitrogenous fertilizer. Nitrate of soda is the most effective fertilizer for quick stimulation of impoverished trees.

Much of the land of the Eastern States best adapted to peach grow-

ing, especially sandy upland, is deficient in lime and is considerably improved by the application of from 20 to 40 bushels, of 80 pounds each, of stone lime, per acre. The lime has rather a general effect on the soil than an immediate effect on the trees, although it acts as a fertilizer to some extent by freeing potash from insoluble combinations in the soil, and is distinctly beneficial to the peach. It is of benefit in many ways to the peach-orchard soil, improving its mechanical, chemical, and biological condition. It flocculates very light, sandy soils, and renders them more compact and more capable of retaining moisture, while it prevents clayey soils from becoming pasty and cloddy by causing them to crumble on drying. Lime is especially desirable where crimson clover is to be grown as a cover crop. The liming of these light, sandy soils greatly favors the "catch" of clover and the development of the clover plants. Its effect on the cowpea is slightly injurious, but good crops of cowpeas may be grown even on the limed land.

Where newly cleared land is planted to peaches in the sections of country benefited by lime, it is especially important to lime such land. It is better to apply lime where needed as a part of the preparation of the land for peaches. Where this has not been done, lime can be used at any time in the young orchard, preferably after a cover crop of cowpeas has been plowed under in early spring. The beneficial effects of an application of lime are supposed to last from five to ten or even twenty years.

RAINFALL AND IRRIGATION.

By Edward A. Beals,
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WATER SUPPLY FIRST CONSIDERATION IN IRRIGATION SYSTEM.

In planning an irrigation system the first question that should receive attention is the water supply, after which the engineering problems connected with the structural work require careful consideration, for many mistakes have been made through misjudging the amount of water that can be depended upon during the time when it is most needed. Information of this character can not be obtained by simply looking at a stream and noting what appears to be an ample supply, as streams vary greatly in volume during each season, as well as in different years.

The amount of water discharged by a river varies even more than the rainfall over its catchment basin, and rainfall the world over is one of the most uncertain of the elements. Take, for instance, the Nile, with its drainage area of over 1,200,000 square miles. One would suppose that it would supply water enough to irrigate at least 200,000 or 300,000 square miles, but its mean daily discharge is capable of watering less than 28,000 square miles with 2 inches of water every ten days, which is the amount needed to mature ordinary crops.

It is necessary, therefore, to give the matter of rainfall close attention in all irrigation questions, and a few general considerations on the subject will be given. Fig. 49 presents roughly the main features of the yearly distribution of rainfall on the land surface of the globe, but it is impossible to picture with scientific exactness on a small scale an element which varies so greatly at places short distances apart, and the chart should be so interpreted.

PROCESSES OF RAIN FORMATION.

While the processes of rain formation have not yet been wholly cleared up, it is known that whenever masses of moist air move quickly from a lower to a higher elevation precipitation occurs. Masses of air acquire up and down movements in three ways: (*a*) Through inequalities of temperature producing changes in density, whereby the heavier air settles and the lighter air rises; (*b*) by horizontally flowing streams of air meeting with an obstruction, such as the slope of a mountain, and thereby being deflected upward by reason of their

momentum; and, (*c*) by rotating masses of air forming a vortex which causes large and powerful ascending currents.

This latter movement is technically known as a cyclone. It is not, however, the so-called cyclone commonly mentioned in the newspapers, which produces destruction over narrow paths, such, for instance, as the storms which occurred in St. Louis and Louisville several years ago; but it is a system of wind movements covering a wide extent of territory, which may have a diameter anywhere from 500 to 2,000 miles, with a vertical dimension rarely exceeding 3 or 4 miles. This circulatory system may be compared to a huge revolving disk, air flowing spirally inward and upward, and which, as a whole, moves from west to east.

This class of atmospheric disturbances when combined with class

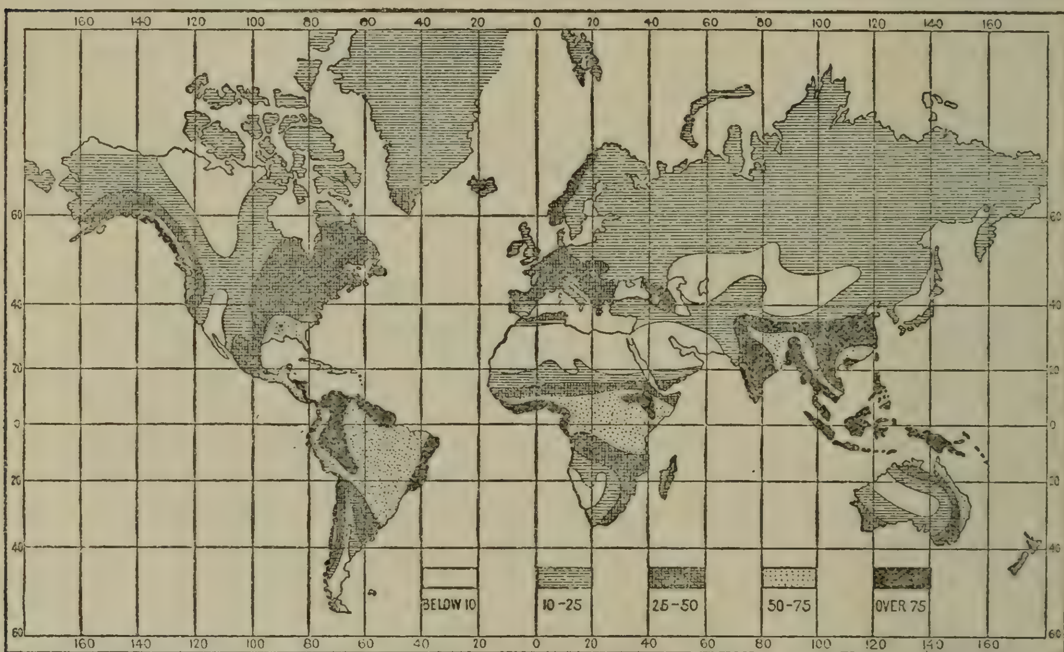

FIG. 49.—Mean annual precipitation on land. (After Loomis, J. Y. Buchanan, and others.)

b, wherein the air is forced up the side of a mountain, produces the heaviest rains that occur in the world.

The path of cyclones is preeminently, in the north temperate latitudes, from the coasts of China and Japan, extending easterly around the globe to the steppes of Siberia, and a large part of the rain which falls in these latitudes is primarily due to this class of disturbances. The rains that fall in the tropical regions are due to convectional movements resulting from the conditions described under class *a*.

There is one great law relating to the distribution of rainfall that needs to be mentioned: it is that it decreases toward the interior of continents; where high mountains are near the sea it decreases very rapidly to the leeward of such ranges. The interiors of continents usually receive their rainfall during the summer months, for then this region is relatively the warmest, and inward-moving currents of

moist air are able to ascend to great elevations before becoming sufficiently cooled to condense their moisture, and at this season of the year they pass over the summits of ordinary ranges, depositing but little, if any, rain. As these currents proceed farther and farther inland, they reach localities that are warmer, which causes the air to expand, and work done in expansion is at the expense of heat.

This movement continues until sufficient heat has been lost to cool the mass down to the dew point, when clouds form, and, if the cooling continues long enough, it is followed by rain, generally as summer thunder showers. It is these thunder showers that make the Upper Mississippi Valley so productive, as the rains from them amount in the aggregate to more than those that fall during the winter. The rain processes in the interior of continents during the summer time are analogous to those taking place in the Tropics and classed under *a*, the difference being largely due to the supply of moisture, which, of course, is more abundant in the Tropics.

MOUNTAINS AS CONDENSERS OF MOISTURE.

From what has been said, it is plain that the mountains are natural condensers of moisture, and they form in nearly every instance the reservoirs from which our streams rise. It is necessary to examine closely what takes place on their slopes if we wish to understand the behavior of the streams that are fed from this source.

In temperate climes by far the greater part of the precipitation that takes place on mountains is in the form of snow, which collects to great depths in canyons and forested areas. Over the bare sides of mountains the snow melts quickly under the influence of the direct rays of the sun, even when the temperature in shaded places is below the freezing point; the ground also is usually hard and nonabsorbent and the water runs off quickly, and not only is the soil washed away, but the streams rise to flood heights, after which the waters quickly subside and often sink beneath the surface and leave the bed of the river quite dry.

Where mountain slopes are covered with forests the conditions attending the melting of snow are altogether different; windfalls, dead leaves, twigs, and branches accumulate on the ground and form a mulch, while the soil beneath is more porous and absorbent than in the case of land bare of timber. The snow, in consequence of the shade from the forest, melts slowly and the water sinks deeply into the ground and forms springs, all of which tend to make the run off slow and steady. It is the water from the numerous springs and soggy places so commonly found in forests that give our rivers their perennial character.

The altitude of the point where precipitation begins varies with the season and with the latitude, being lowest during the coldest months and in northern latitudes, and highest in the summer time and in

lower latitudes. Because of these facts the snow extends well down the mountain slopes, and remains there until melted in the spring. The snow which falls on the high peaks is of little importance, as the area thus covered is relatively small. The altitude of maximum rainfall also varies with the latitude and the season of the year; in northern India the heaviest rains occur at an elevation slightly above 4,000 feet, and in some parts of the United States it is probable that the region of heaviest rainfall is somewhat higher.

The evaporation taking place from melting snow increases the humidity about the mountains, and as the air drifts to other regions it adds to the possibility of rain occurring elsewhere, as evaporation over the land supplies an important proportion of the moisture that falls as summer showers.

Professor Carpenter has shown by direct measurements of streams that during spring rains the cloudiness attending them prevents the snow in the mountains from melting, and the run-off from the rain is less than that which would have occurred from the melting snow had the attending cloudiness been replaced by bright sunshine. This illustrates another property of snow to conserve moisture, as in this case the run-off is diminished, while at the same time the available water supply is increased.

IRRIGATION FOR THE RICE CROP.

Although accurate statistics are not available, it is probable that more land is under irrigation for the rice crop than for all other crops combined. China, Japan, and the Malay countries of southeastern Asia are the seat of these irrigation systems. Rice is a water plant, and from germination until the time of flowering needs to be covered to a depth of from 1 to 3 inches with water; therefore the quantity used is enormous. In portions of India it is claimed that the natural rainfall of between 20 and 30 inches has to be supplemented during the growing season by from 35 to 40 inches from the irrigating canals, which would make the amount of water needed for maturing rice about 60 inches.

Great economy is used in raising this crop by the Oriental races. They lay out their land in small patches that to the eye seem perfectly level, but there is just sufficient slope to allow the water to drain slowly through the furrows until the field is covered. The fields, or paddies, are arranged in terraces, one a few inches below another, and the water is allowed to drain from one field to the next, and in this way it is used over and over again.

IRRIGATION SYSTEMS OF THE WORLD.

Excluding the rice-irrigation system of China, Japan, and southeastern Asia, there are some fifty or more millions of acres of irrigated land in the world, and of this great area fully one-half is located in

countries having a humid or semihumid climate, with an annual rainfall above 20 inches. The really arid lands are confined to scattered sections in the western half of the United States, Argentina, and in the Valley of the Nile below Assuan, some 500 miles from the Mediterranean Sea.

IRRIGATION IN INDIA.

The most extensive system of irrigation to-day is in India, where it is calculated that at least 25 million out of a total cultivated area of 144 million acres are irrigated. The principal canals are in the Ganges and the Indus valleys, although they are found elsewhere in nearly if not in every province of the country. Besides the canals built under the direction of the Government, thousands of small tanks or reservoirs are distributed throughout the Empire. The crops raised from water supplied by these tanks are estimated to support at least 20 million people, so the magnitude of these works can hardly be realized.

The snows falling on the Himalaya Mountains during the northeast monsoon furnish the reservoir from which comes much of the water used in the irrigation canals of northern India. The melting of these snows occurs during the hot months of March, April, and May, or prior to the southwest monsoon, and the water thus obtained comes just at the right time for the wheat crop.

About once in seven years great famines occur in India, notwithstanding the average rainfall is 40.6 inches, and that 90 per cent of it falls during the period from May to December. The regions most liable to droughts and their resulting famines are in those sections that have a rainfall above 20 inches. (See fig. 50.)

The dry and wet seasons do not occur in different places at the same time. In the west and in the interior the wet season is during the summer, and in the southeast and east the wettest months are those of winter.

The rainfall is quite unevenly distributed, decreasing rapidly from about 115 inches near the Himalaya foothills to 6 inches in the upper Sind Province, less than 350 miles away. It is heavy near the coast line in the southern portion of the peninsula, where it ranges between 80 and 100 inches.

The greatest known rainfall in the world occurs on the southern slope of the Himalaya Mountains about 200 miles back from the Bay of Bengal. The rainfall at an elevation of 4,455 feet averages 474 inches yearly, nearly all of which falls during the five months from May to September, and as high as 40.8 inches have been measured in a single day.

On the slope of the western Ghats in southern India, at an altitude of 4,540 feet, the rainfall is also very heavy, and averages 261 inches yearly. East of these mountains, in the Deccan Plateau, the rainfall

again diminishes to an average amount approximating 20 inches for the whole plateau, but at Hyderabad the average is 32.9 inches.

IRRIGATION IN EGYPT.

The lower Valley of the Nile, including its delta, comprises another great irrigation system, with over 6 million acres under cultivation. Egypt is wholly different from India as far as rainfall is concerned, being so arid that dry farming is impossible. The irrigated area begins at Assuan, about 500 miles from the Mediterranean Sea. The valley above the delta is narrow, with a tillable breadth averaging probably less than 9 miles.

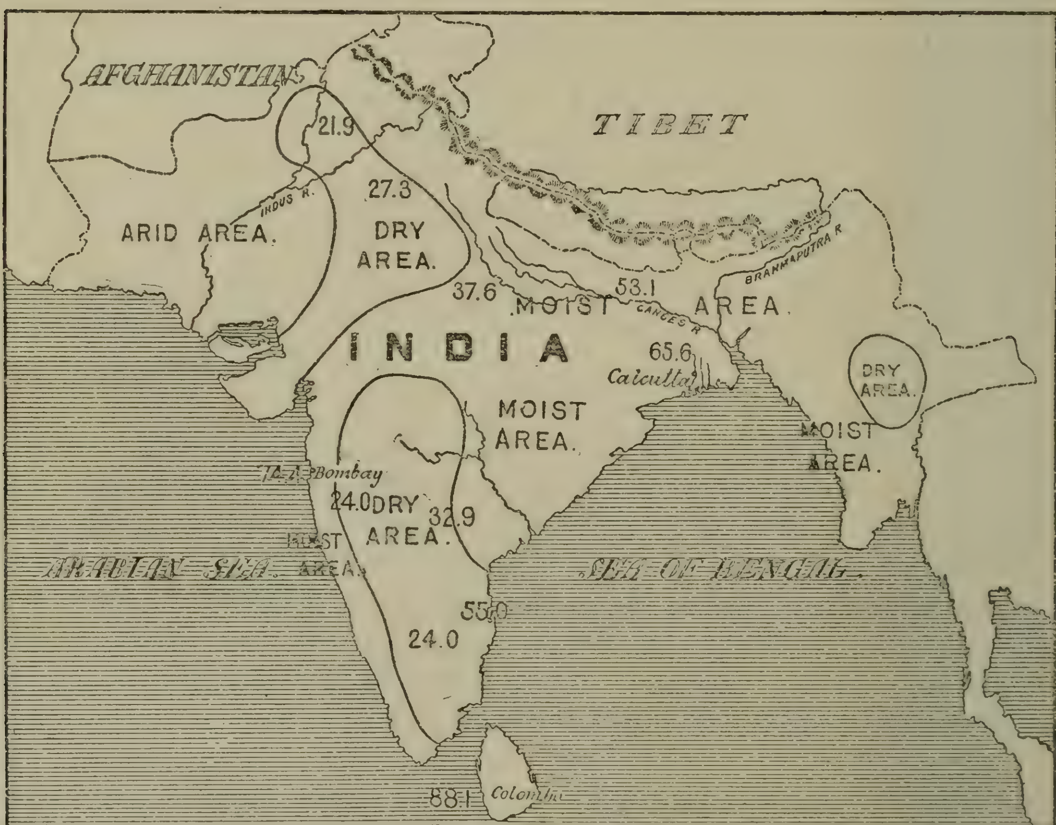

Fig. 50.—Average annual precipitation in India. (After Eliot.)

Owing to the absence of gauge measurements, the exact rainfall over much of the catchment basin has not been determined. At Alexandria the annual rainfall is 8.8 inches, the whole of which falls between September and April, with January as the wettest month. The same distribution occurs at Cairo, but the annual amount is only 1.3 inches. As far as the crops are concerned the natural rainfall in the irrigated sections of Egypt might as well be ignored.

The waters of the Nile are supplied by heavy rains in the equatorial regions at the source of the White Nile, which fill the reservoirs of Lake Victoria, area, 27,027 square miles; Lake Albert, area, 1,737 square miles, and Lake Edward, area, 1,930 square miles. These

natural reservoirs help materially to keep up the constant flow in the lower Nile during its minimum height, as without them the river, flowing through such a long stretch of desert, would probably go dry before it reached the sea.

The rainfall at the headwaters of the White Nile is estimated to be above 80 inches annually, and its maximum occurs in August.

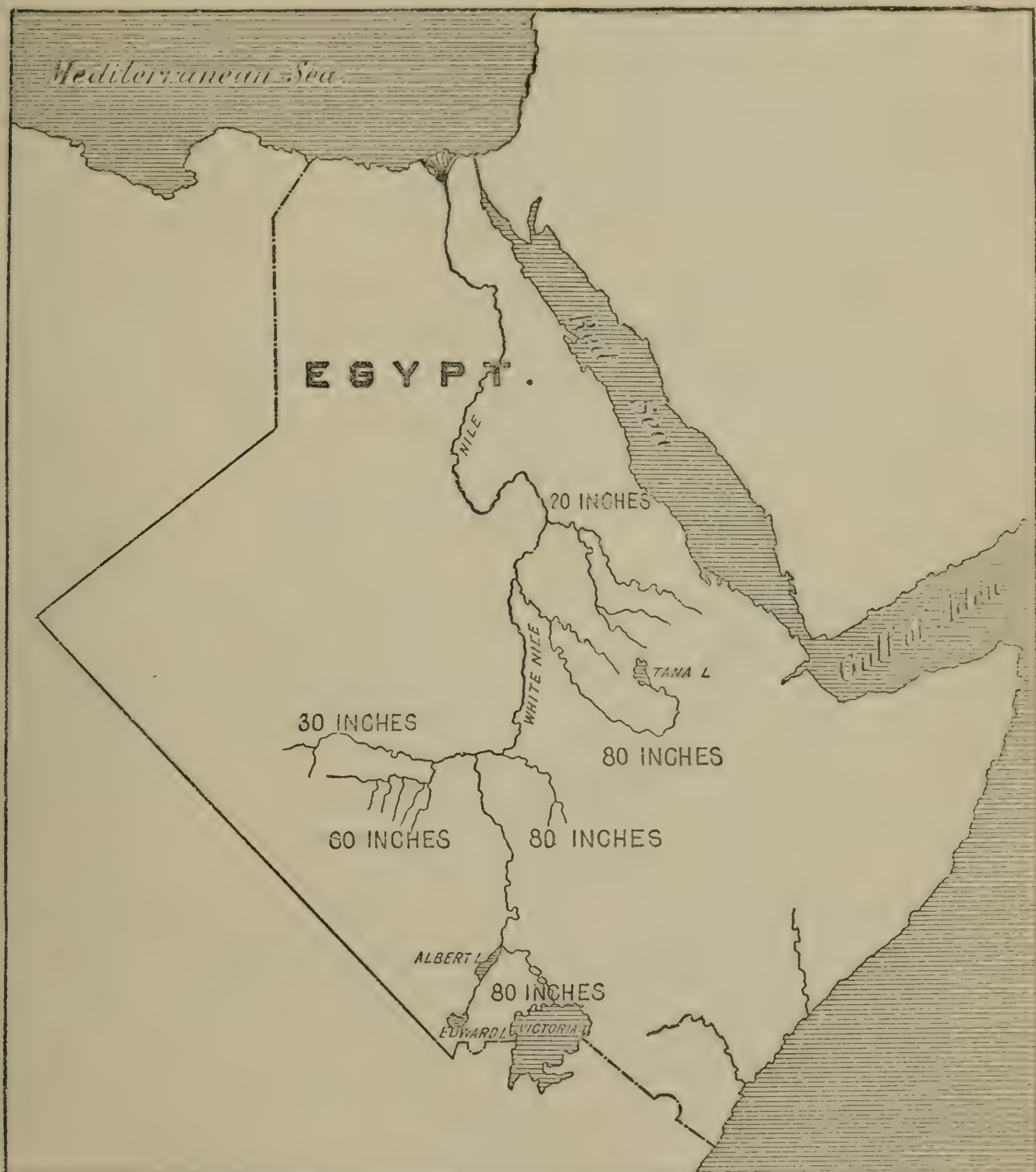

FIG. 51.—Mean annual precipitation, headwaters of the Nile, Egypt.

The Blue Nile, with its source in the mountains of Abyssinia, has also Lake Tsana, area, 1,158 square miles, as a reservoir. The rainfall at its headwaters is also 80 inches. The flood crest from this stream reaches Cairo about October 1, and causes a rising river during July, August, and September. Fig. 51 shows the Valley of the Nile and the rainfall distribution as far as known.

The dam at Assuan, which has just been completed, has a storage

capacity of over 30 billion cubic feet. It is built of granite, and is 70 feet high, 23 feet wide at top, 82 feet wide at bottom, and 1¼ miles long. It is expected it will do much toward regulating the supply of water, the natural flow of which is too high during three months of the year and too low during the remaining nine months.

IRRIGATION IN THE EUPHRATES BASIN.

Passing now from Egypt to southwestern Asia, we find that whereas no great irrigation plants are in operation, yet individual efforts amount in the aggregate to a large territory artificially supplied with water. The rainfall in this region is scant, although dry farming is extensively carried on despite many failures. The system employed in getting the water on the land is about the same now as it was in biblical times.

The mountains to the east receive the most rainfall, and thence westward the amount diminishes until the desert of Arabia is reached. The catchment area of the Euphrates Basin is about 250,000 square miles, and much irrigation is done in this valley. The following table gives the rainfall of the basin:

Rainfall of the Euphrates Basin.

Locality.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
	Ins.	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*
Harpoot	1.32	2.74	4.53	2.15	1.82	0.92	0.01	0.02	0.17	2.55	0.80	2.99	20.02
Aintab	3.56	3.48	2.91	2.48	1.38	.21	.08	.02	.02	.82	3.32	4.55	22.71
Mosul	3.19	2.36	1.54	1.58	.24	.04	.00	.00	.00	.51	.67	2.05	12.18
Bagdad	1.57	2.48	1.93	1.18	.28	.02	.00	.12	.02	.04	1.02	1.97	10.63

IRRIGATION IN ITALY.

From Asia we now proceed to Italy, a country that has inherited from the Romans of early days a full knowledge of methods for conveying water to the land by means of aqueducts and canals. It is estimated that 4,715,000 acres are under irrigation in that country. The Valley of the Po contains the largest canal system, and besides wheat, barley, hemp, rye grass, clover, rice, and corn, raised by the help of irrigation, extensive mulberry orchards for the feeding of silk worms are kept in a thrifty state by water supplied by these canals. In southern Italy and in Sicily nearly all fruit culture is assisted by irrigation.

The annual rainfall ranges between 20 and 30 inches. In the Valley of the Po the average is 30 inches, and along the west coast it is about the same until Sicily is reached, when the amount decreases to between 20 and 23 inches. The Alps divide the region of summer rains in Europe from those of winter, and in Italy the summers are

prevailingly dry; hence the need of irrigation with an annual rainfall approximating 25 inches. It is the winter snows in the Alps that conserve the moisture for the Po, and the many small lakes found on the plains of Lombardy form the reservoirs for irrigating that district. Elsewhere the water supply is derived principally from wells and small streams.

IRRIGATION IN SPAIN.

In Spain about 5 million acres receive the benefit of irrigation. In the northern provinces irrigation is not absolutely necessary, but it is used extensively to increase the yields of meadows and cereals; in the southern provinces it is necessary on account of the scanty rainfall during the growing season, and it is used principally for fruit and vegetables.

The irrigation systems in Spain are mostly owned by private individuals and corporations, but the Government in former years built some large works which it continues to operate. In the north central portion of the country, which is known as the "Corn barn of Spain," a system of canals is in operation whose water is not only used for irrigating the land, but as the motive power for a number of mills and factories, while the canals serve also as a water road for barges carrying as high as 33 tons each.

The rainfall of Spain is distributed much like that of Italy, but the extremes are greater. On the north coast the rainfall is heavy, averaging over 50 inches, while at Madrid, near the center of the country, it is only 17½ inches, and farther south it is still less.

IRRIGATION IN FRANCE.

Roughly estimated, there are 5,800,000 acres of land in France subjected to irrigation. The principal canals are confined to the valleys of the Rhone and the Garonne, while in central France water is obtained from wells, springs, and small reservoirs. In the northern provinces small streams are numerous, and most of the water used is taken from them. Irrigation waters in this section are applied principally to pastures and meadows to increase the yields of grass and hay. The annual rainfall is estimated to be 30½ inches.

In the southern section the average is 25 inches, and the summers are relatively dry. At Paris it is 22 inches, and at Cherbourg, on the English Channel, the annual fall is 40 inches. In the central and northern districts the seasonal distribution is more uniform, and about the same amount falls in summer as in winter.

Besides these countries in southwestern Europe irrigation is practiced in many other parts of the continent, but nowhere on an extended scale.

IRRIGATION IN AUSTRALIA.

Extensive systems of irrigation are planned for Australia, but as yet little has been done in that country. The rainfall is scanty, and it varies greatly from year to year. The last three years have been droughty, and it is reported that out of a total of 120 million sheep 40 million have died on account of the drying up of the pastures. The rainfall for the whole continent is about 21 inches, computed as follows:

	Inches.
Western Australia	23.37
South Australia	21.29
Victoria	31.65
New South Wales	24.71
Queensland	27.53
Interior (estimated)	10.00

On the eastern coast the rains are heaviest in the summer and early autumn; in the interior the distribution is very irregular, and in the south and west there is a winter maximum, with dry weather during the summer and the early autumn. The small rainfall in this country is due to the fringe of mountains skirting the continent, which are not high enough to collect snow, and therefore it will never be possible to irrigate much land, even if all the water be utilized. The rivers draining into the interior run dry before they reach far from their source, and the perennial streams draining the coastal slopes run in short courses to the sea.

The Australians are at present chiefly interested in irrigation of orchards, vineyards, and gardens. In the future irrigation for the purpose of producing fodder for horses, cattle, and sheep and to accumulate a reserve supply of feed for all kinds of stock during dry seasons will assume great importance.

IRRIGATION IN MEXICO AND ARGENTINA.

Irrigation is practiced to a moderate extent in Mexico and Argentina.

Mexico.—In Mexico, like Australia, the river system is extremely limited, and those flowing through the country soon run dry. The rainy season extends from June 1 to October 1, and during the remainder of the year water is very scarce, except along the seaboard.

Argentina.—In South America irrigation is to-day confined principally to Argentina, although before the conquest great systems were in operation in the country of the Incas. In Argentina the provinces where irrigation is necessary are those situated in the northwest and lying near the Cordilleras. The table and fig. 52 on the next page show (1) the territory which requires irrigation, and (2) the annual and seasonal distribution of rainfall.

Rainfall in the irrigated sections of Argentina.

Province.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
	Ins.	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*
Tucuman	9.47	5.05	6.98	1.33	9.34	0.72	0.48	0.07	0.75	2.94	4.71	5.80	39.65
Cordoba	2.10	2.25	3.16	1.34	1.53	.05	.14	.00	.24	1.59	5.04	4.86	22.29
San Juan	1.16	.94	.09	.00	.07	.04	.02	.15	.00	.20	.28	.52	3.47
Mendoza	.19	.28	1.31	.25	.08	.21	.19	.19	.34	.38	.75	.48	5.19

The water supply comes from the rivers having their source in the mountains, but unfortunately those running through sections most

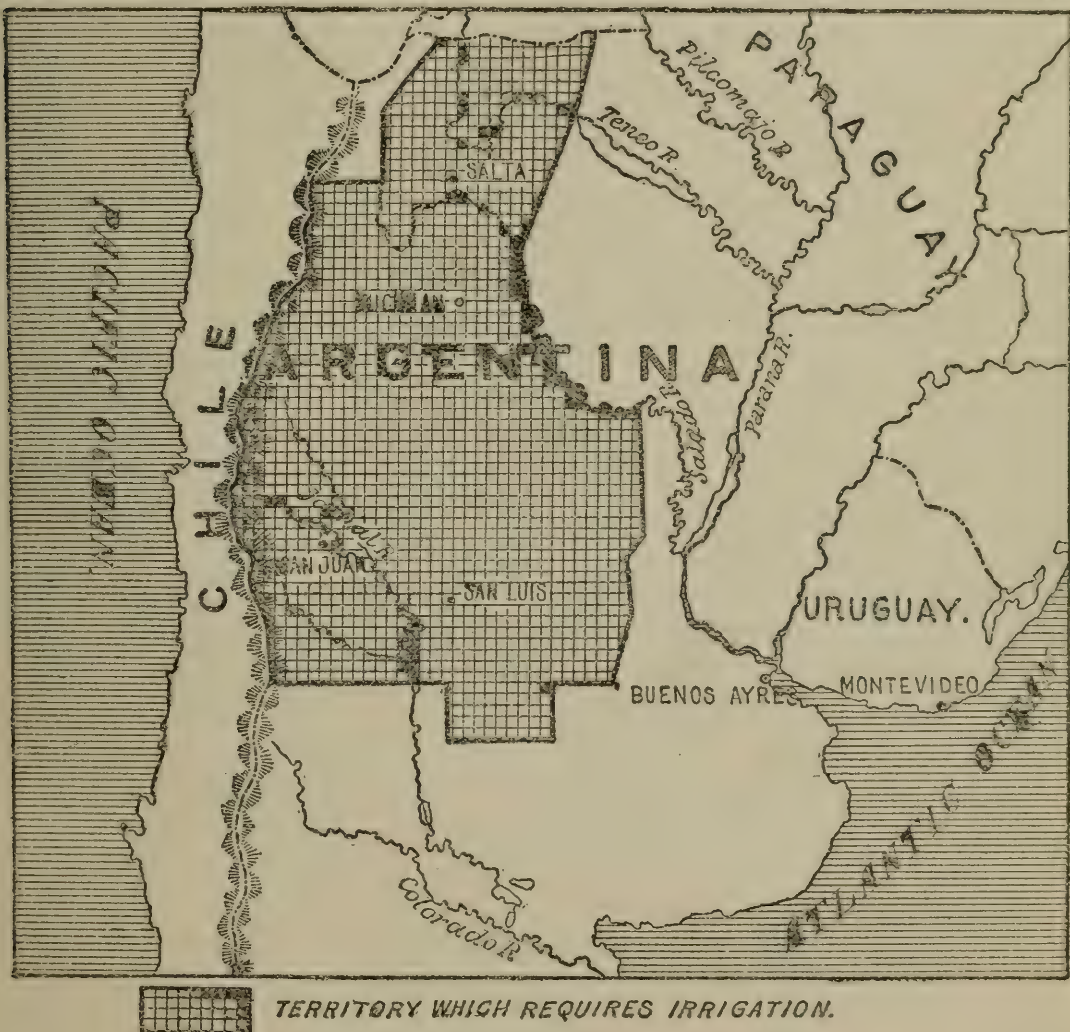

Fig. 52.—Territory in Argentina which requires irrigation.

needing irrigation have very unequal flows, being at flood heights during the rainy season and at the time of the melting of the snow, but later drying up and remaining so for four or five months of the year. These rivers, like those in the interior of Australia and Mexico, have no outlets, but are swallowed up in sands and marshes.

IRRIGATION IN THE UNITED STATES.

India, with not quite half the area of the United States, and containing about four times as many people, finds it necessary to aid its

agriculture during occasional periods of drought by an extensive system of irrigation, notwithstanding that it is a fairly well watered country. If the population of the United States keeps on increasing in the same ratio as in the past, the time is not far distant when this country will have not only to irrigate the semiarid regions of the West to their utmost limits, but will also have to establish canals in the fertile valleys of the East for the purpose of increasing the yields now obtained and also to bring under cultivation the sandy, barren patches of land lying waste, and which need only frequent and abundant watering to produce profitable crops.

The success of the harvest in every country depends upon the rainfall at critical periods in plant growth, for many small wettings of the soil do little good after the crop has become well rooted, and they may even be harmful in causing a more rapid evaporation from the subsoil, which dries out faster than would otherwise be the case. One or two good soaking rains are absolutely essential between the time of germination and the ripening of plants. If nature does not supply them, vegetation withers and partial or total crop failures occur, depending upon the quality of the soil, the manner of cultivation, and the length of the drought. On the other hand, with irrigation water available at these critical times, the crop suffers no harm and full yields are obtained. Professor King estimates that in well watered Wisconsin there is hardly a year in which the yields of one or more of the staple crops could not have been doubled if the water supply of the State were larger and under better control.

According to the last census, 7,263,273 acres were being irrigated in the United States in 1899. This is a gain within the last ten years of 103.8 per cent, apportioned among the different States as follows:

States practicing irrigation.

State or Territory.	Acres.	Gain last ten years.
		Per cent.
Arizona	185,396	181.7
California	1,445,872	44
Colorado	1,611,271	80.9
Idaho	602,568	177.7
Montana	951,154	171.3
Nevada	504,168	124.7
New Mexico	203,893	122.2
Oregon	388,310	118.2
Utah	629,293	138.8
Washington	135,470	177.6
Wyoming	605,878	163.8

The total cost of the irrigation systems of the United States is $64,289,601, and the value of the irrigated crops for the single year of 1899 was $84,433,438, or 30 per cent greater than the cost of the plants. The number of irrigators was 102,819, which gives nearly 71

acres to each farm. The value of crops raised by irrigation in 1899, arranged in the order of their importance, was as follows:

Hay and forage	$34,834,966
Cereals	14,338,326
Vegetables	9,627,491
Orchard fruits	8,920,409
Small fruits	1,087,407
Other crops	15,624,839

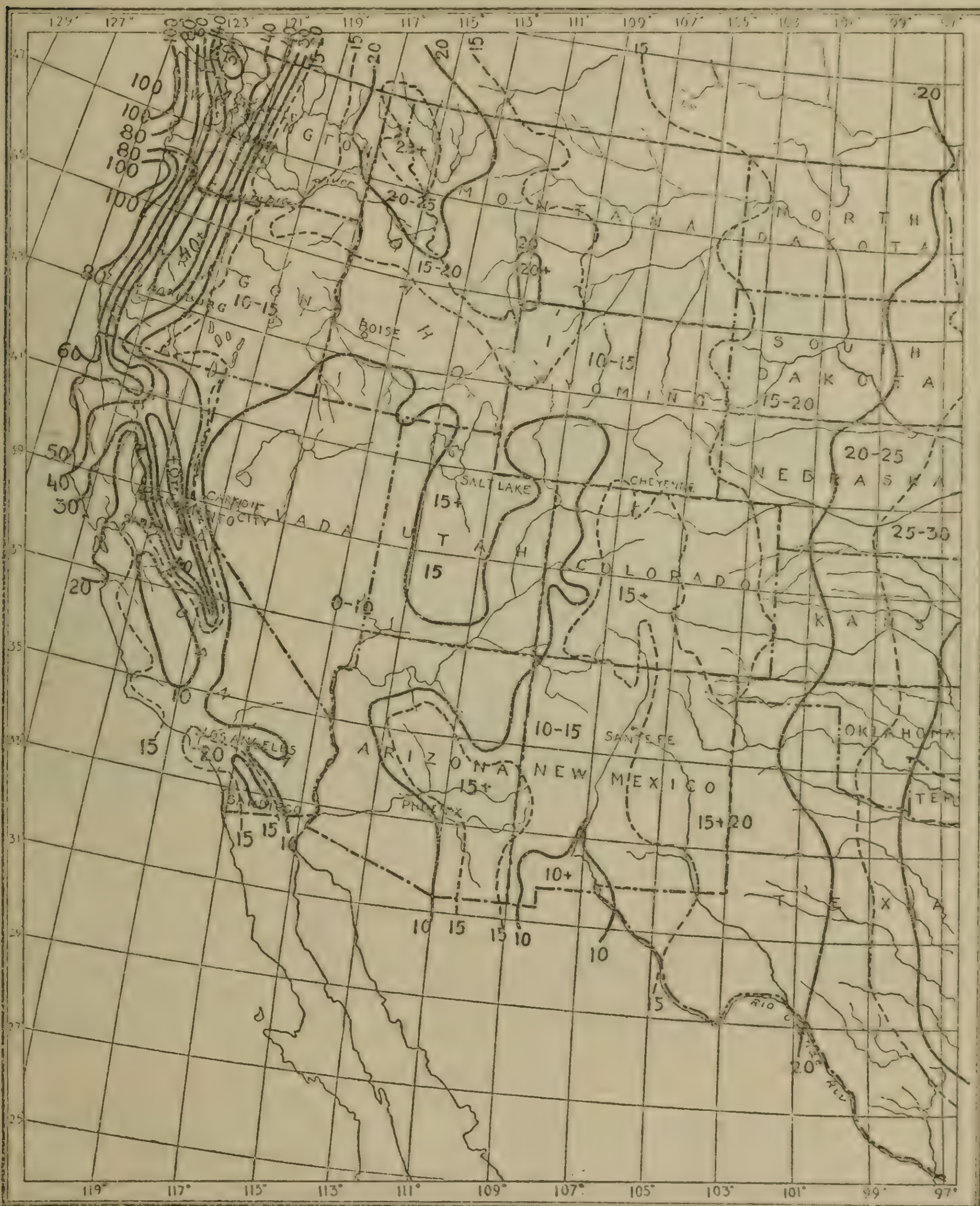

FIG. 53.—Average annual precipitation in the western portion of the United States, 1871-1901.

As irrigation in the United States is carried on principally west of the one hundredth meridian, the rainfall only of that region will be described. Fig. 53, by Prof. A. J. Henry, shows graphically the annual distribution, but like the rainfall chart of the globe, one can not on so small a scale portray the conditions with scientific exactness.

In southwestern Arizona and extreme southeastern California the rainfall is less than anywhere else in the United States, being between 2 and 3 inches, while near the Washington and Oregon coasts the average is slightly above 100 inches. Between these extremes the amounts vary considerably, but in general they are insufficient for dry farming, although California, Oregon, Washington, and Idaho raise large crops of wheat on land receiving less than 20 inches of water annually.

SEASONAL DISTRIBUTION OF RAINFALL IN THE IRRIGATED REGION OF THE UNITED STATES.

The seasonal distribution of rainfall west of the one hundredth meridian presents six types, which have been described by Prof. A. J. Henry, of the United States Weather Bureau, as follows:

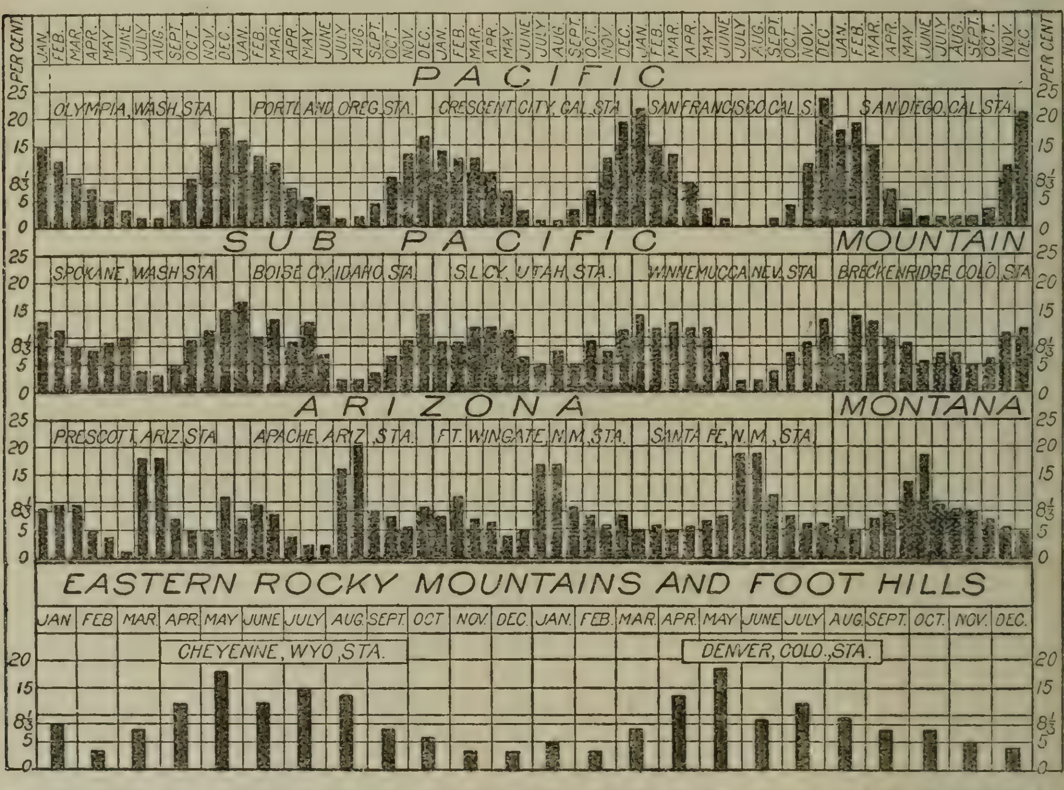

FIG. 54.—Types of monthly distribution of precipitation in the western portion of the United States.

PACIFIC TYPE.

This type is found in all the territory west of the Cascade and Sierra Nevada ranges, and also obtains in the fringe of country to the eastward of the mountain summits. It is represented by the profiles of Olympia, Wash.; Portland, Oreg.; Crescent City, San Francisco, and San Diego, Cal. (fig. 54), where the heavy black vertical lines represent the precipitation of each month expressed as a percentage of the annual rainfall.

A light horizontal line has been inserted at the point on the vertical scale corresponding to $8\frac{1}{3}$ per cent for convenience in comparing the distribution at the different stations, it being remembered that if the precipitation were uniformly distributed throughout the year the heavy vertical lines would terminate at the point where they intersect the line of $8\frac{1}{3}$ per cent.

The distinguishing characteristic of the Pacific type is the wet season, extending from October to March, and a practically rainless summer, except in northern California and parts of Oregon and Washington. About half of the yearly precipitation comes in the months of December, January, and February, the remaining half being distributed throughout the remaining seven months—September, October, November, March, April, May, and June.

SUB-PACIFIC.

The term "sub-Pacific" has been given to that type of rainfall which obtains over eastern Washington, Idaho, Nevada, and Utah. The influences that control the precipitation of this region are much similar to those which prevail west of the Sierra Nevada and Cascade ranges. There is not, however, as in the Pacific type, a steady diminution of the winter precipitation with the approach of spring, but rather an increase which culminates in the late spring months. (See the profile of Spokane, fig. 54.) This fact is of very great importance to the agricultural interests, whether the natural rainfall is sufficient for the growth and maturity of staple crops or not. In the latter case the rain comes at the time when most needed for irrigation. Salt Lake City has been placed within the sub-Pacific group, although its profile is not similar in all respects to those of the remaining stations. The differences are probably due to the influence of the lake.

ARIZONA.

The Arizona type, so called because it is more fully developed in that Territory than elsewhere, prevails over Arizona, New Mexico, and a small portion of southern Utah and Nevada. This type, of which Prescott, Fort Apache, Fort Wingate, and Santa Fe are examples, differs from all the others in the fact that about 35 per cent of the rain falls in July and August. May and June are generally the months of least rainfall. The summer rains are essentially a feature of the mountain and plateau systems of both Territories, and are believed to be due largely to local convection, induced by excessive insolation on the barren, rocky surface of the mountain sides and summits. The winter rains are believed to be due to migratory areas of low pressure pertaining to the general system of storm movement. The character of the winter rains, whether light or heavy, depends largely on the frequency of atmospheric disturbances and especially their movement in latitude.

MOUNTAIN.

The Mountain type is represented on the diagram (fig. 54) by one station only, Breckenridge, Colo., situated on the western divide of the Rocky Mountains at an elevation of about 9,500 feet above sea level. The observations extend over a little more than seven years, and the type is therefore a provisional one only. It is characterized by heavy snowfall in the winter and spring months and a secondary maximum of rain in July and August, and seems to stand in rather close relation to the Pacific and Arizona types.

MONTANA.

The rainy season in Montana is confined to May and June, 33 per cent of the annual amount falling in these months. The rainfall of the remainder of the year, although small, is well distributed for agricultural purposes.

THE EASTERN FOOTHILLS.

A type closely allied to that of the plains to the eastward. The Rocky Mountains form a dividing line between diametrically opposite rainfall types. West of

the mountains, except in Arizona and New Mexico, the bulk of the rain falls in the colder months of the year, but in crossing the range the rainy season is transferred to the warmer months. In the foothills region it occurs in April and May; in Montana, in May and June. On the plains proper and eastward to Michigan and Indiana it falls in May, June, and July, while on the South Atlantic and Gulf coasts it occurs in August and September with but few exceptions.

The rainfall on the eastern foothills region is not abundant, but what there is comes at the most important time of the year. This type is represented by the profiles of Denver and Cheyenne.

CONCLUSION.

It is not within the province of this paper to discuss the possibilities of agriculture under irrigation in the semiarid or arid regions of the United States, but it may not be amiss to state that the climate in respect to temperature and sunshine is most favorable, and the soil, where not too heavily charged with alkaline salts, brings forth quickly and abundantly all crops suitable to a temperate climate.

FOOT-AND-MOUTH DISEASE.

By D. E. Salmon, D. V. M.,
Chief of the Bureau of Animal Industry.

DISCOVERY OF LATEST OUTBREAK IN UNITED STATES.

An unexpected outbreak of foot-and-mouth disease was discovered in Massachusetts and Rhode Island in November, 1902. The Department of Agriculture first received an intimation of the existence of this disease on November 14, 1902, in a letter from Dr. Austin Peters, chief of the Cattle Bureau of Massachusetts. This letter stated that a disease resembling foot-and-mouth disease had been discovered in Rhode Island, and that an investigation would be immediately made and the results reported. On November 17 Dr. Peters telegraphed that he believed the malady to be foot-and-mouth disease. Immediately upon receipt of this telegram, Dr. John R. Mohler, chief of the pathological division of the Bureau of Animal Industry, was sent to Massachusetts to investigate and report upon the disease existing in that section of the United States. Dr. Mohler reported in a letter received November 24 that the disease was probably the European foot-and-mouth disease, and gave sufficient details as to symptoms and nature to allow an intelligent opinion to be formed. A calf and two sheep which he inoculated contracted the disease within two, four, and five days, respectively.

MEASURES TO PREVENT SPREAD OF THE DISEASE.

As there was no history of the introduction of affected animals into the United States, and a declaration of the existence of the disease would have such serious consequences in commercial restrictions, it was deemed advisable to have additional expert opinions. Dr. Leonard Pearson, dean of the veterinary department of the University of Pennsylvania, and Prof. James Law, dean of the New York State Veterinary College, were at once asked to proceed to Massachusetts and give an opinion as to the nature of the disease. Their joint report pronouncing the malady to be foot-and-mouth disease beyond doubt was received November 27, and the quarantine order on the next page was promulgated the same day.

QUARANTINE OF CATTLE, SHEEP, AND OTHER RUMINANTS, AND SWINE, IN THE NEW ENGLAND STATES.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY,
Washington, D. C., November 27, 1902.

To the managers and agents of railroads and transportation companies of the United States, stockmen, and others:

In accordance with section 7 of the act of Congress approved May 29, 1884, entitled "An act for the establishment of a Bureau of Animal Industry, to prevent the exportation of diseased cattle, and to provide means for the suppression and extirpation of pleuro-pneumonia and other contagious diseases among domestic animals," and the act of Congress approved June 3, 1902, making appropriations for the Department of Agriculture for the fiscal year ending June 30, 1903, you are hereby notified that the contagious disease known as foot-and-mouth disease exists among animals in the States of Connecticut, Rhode Island, Massachusetts, and Vermont, and that the cattle, sheep, and other ruminants, and swine, of said States have been exposed to the contagion of said disease: Therefore,

It is hereby ordered, That, to prevent the spread of the said disease from the States of Connecticut, Rhode Island, Massachusetts, and Vermont into other States or foreign countries, and to aid in its eradication, no cattle, sheep, or other ruminants, or swine shall be moved or be permitted to move from or across the territory of any one of the States above named into any other State or foreign country. Any person, company, or corporation violating this order will be proceeded against as provided for by the act of Congress above referred to.

It is hoped that all transportation companies, cattle shippers, and others interested in the welfare of our animal industry will cooperate with the Department of Agriculture in enforcing this order, to the end that the restriction on traffic may have the desired effect and be removed in the shortest possible time.

JAMES WILSON, *Secretary.*

An order was also issued prohibiting the exportation of animals from the port of Boston, as follows:

PROHIBITION OF THE EXPORTATION OF CATTLE, SHEEP, AND OTHER RUMINANTS, AND SWINE, FROM THE PORT OF BOSTON.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY,
Washington, D. C., November 27, 1902.

Whereas a highly contagious disease, known as foot-and-mouth disease, exists among cattle in the State of Massachusetts, and the routes of transportation possibly may have been contaminated, and, in order to protect the export trade in live animals by preventing the exportation of animals which are diseased or which have been exposed to disease,

It is hereby ordered, That no cattle, sheep, or other ruminants or swine, shall be permitted to be exported from the port of Boston until further orders.

JAMES WILSON, *Secretary.*

On the 1st day of December the writer went to Massachusetts to supervise and direct the Federal work of eradicating the disease. In the meantime, a number of veterinarians in the service of the Bureau of Animal Industry in various parts of the country had been hurriedly summoned to Boston to supplement the local force. Dr. S. E. Bennett,

the Bureau's chief inspector at Boston, was placed in charge of the force.

DISTRIBUTION OF THE DISEASE AND MEASURES FOR ERADICATION.

It appeared that the disease had existed in Massachusetts since August, and had extended over the eastern part of that State and into Vermont, New Hampshire, and Rhode Island. At that time the disease had not been discovered in Vermont, but its existence was strongly suspected. Investigation afterwards showed that a single center of contagion existed in that State, and that about 20 herds were affected. Four herds were subsequently found affected in New Hampshire, but as they were immediately slaughtered no general quarantine was placed upon that State at that time.[a] A careful investigation as to the condition of Connecticut failed to reveal any evidence of the disease, or anything to show that the contagion had existed there, and the quarantine on that State was therefore removed by an order dated December 22, 1902.

Fig. 55 shows the distribution of the disease in the States named. In many instances there were several diseased herds in a single town or township. Since March 1, 1903, when the map was prepared, the disease has been found at the following additional places in New Hampshire: Dunbarton, Goffstown, Hampstead, Henniker, Hookset, Manchester, New Boston, Riverdale, and Weare.

With such a comparatively wide distribution of the contagion at the time the disease was discovered, it was a serious problem to decide as to the best method of handling it in order to prevent the further dissemination of the disease, and to guard so far as possible against the danger of its spread to other States. It was also important to take such measures as would prevent the escape of the contagion from control and its spread over the whole of the United States. At the time the Federal quarantine was established and the work of repression begun, the disease was spreading very rapidly and new herds were daily becoming affected. After carefully considering the conditions which existed and the enormous loss with which the country was menaced by the spread of the contagion, it was decided to slaughter the diseased animals as soon as this could be done, and to thoroughly disinfect the buildings in which they had been sheltered. As a basis of compensation, an agreement was made with the governor of Massachusetts that the animals would be appraised at their value as if in good health, and that 70 per cent of this appraisement would be paid as compensation to the owners by the Federal Government.

The disease was so easily carried from stable to stable by persons that it was necessary to take special precautions to prevent its spread

[a] Later the disease was found to exist more extensively in New Hampshire, and on March 7, 1903, the Department of Agriculture issued an order quarantining that State.

by the inspectors who must necessarily visit the diseased herds and who must make investigations of suspected herds. To avoid this

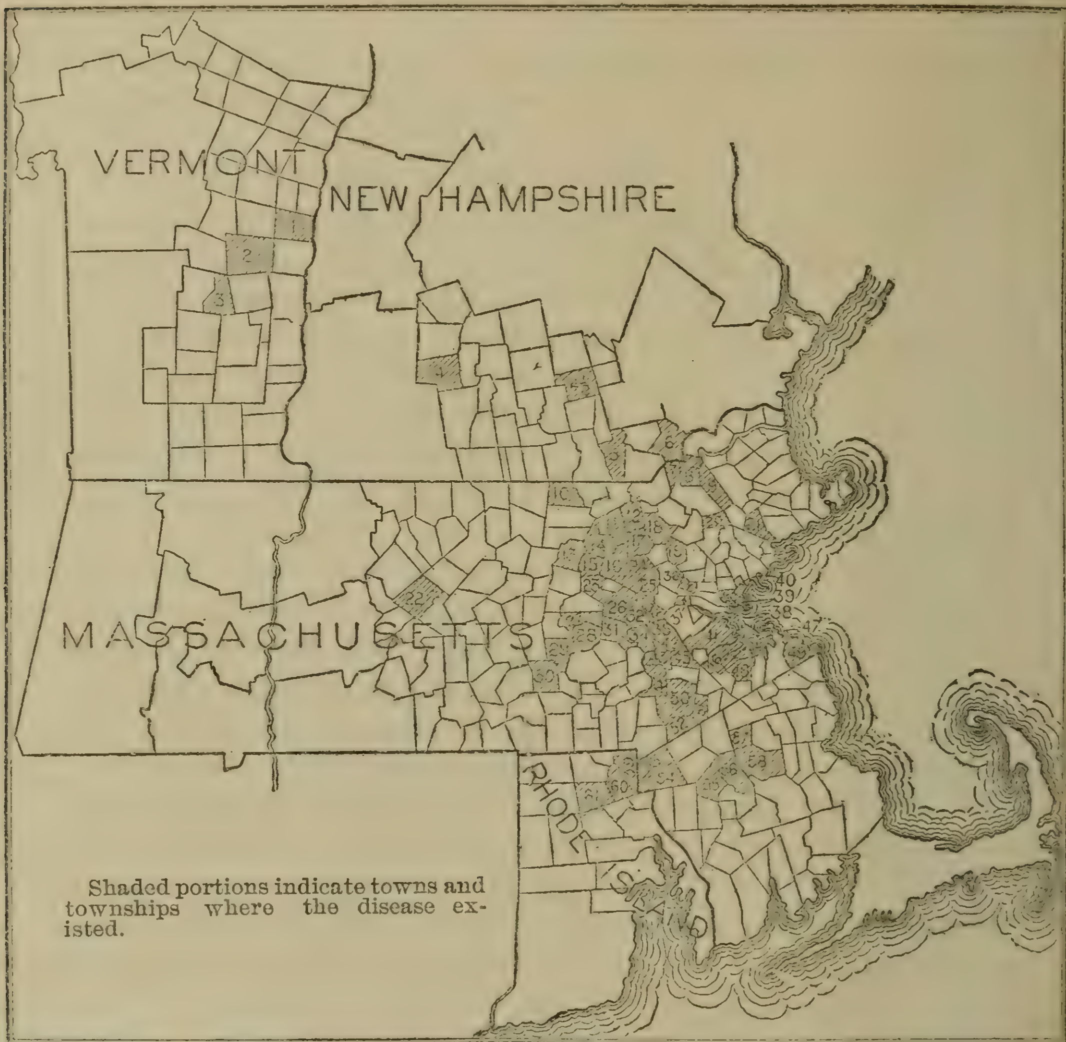

FIG. 55.—Distribution of foot-and-mouth disease in the New England States.

KEY TO NUMBERS ON MAP.

Vermont.

1. Perkinsville.
2. Chester.
3. Windham.

New Hampshire.

4. Hancock.
4½. Bedford.
5. Hudson.
6. Salem.

Massachusetts.

7. Methuen.
8. Lawrence.
9. North Andover.
10. Pepperell.
11. Westford.
12. Chelmsford.
13. Harvard.
14. Littleton.
15. Boxboro.
16. Acton.
17. Carlisle.
18. Billerica.
19. Burlington.
20. North Reading.
21. Danvers.
22. Barre.
23. Stow.
24. Concord.
25. Lincoln.
26. Sudbury.
27. Marlboro.
28. Southboro.
29. Westboro.
30. Grafton.
31. Framingham.
32. Wayland.
33. Weston.
34. Natick.
35. Wellesley.
36. Arlington.
37. Watertown.
38. Everett.
39. Chelsea.
40. Revere
41. Boston (Brighton and Dorchester).
42. Needham.
43. Dover.
44. Medfield.
45. Dedham.
46. Milton.
47. Quincy.
48. Braintree.
49. Cohasset.
50. Walpole.
51. Sharon.
52. Foxboro.
53. North Attleboro.
54. Attleboro.
55. Taunton.
56. Raynham.
57. West Bridgewater.
58. Bridgewater.

Rhode Island.

59. Cumberland.
60. Lincoln.
61. Smithfield.

danger so far as possible, the inspectors were instructed to carry with them rubber caps, coats, and boots, which were to be worn while they were in the stables and sponged off with a disinfecting solution before

they left the premises. In addition to this, it was finally decided that the inspectors should also have rubber cloaks which would tie tightly around the neck and reach the ground, by the use of which the entire clothing might be disinfected in a few minutes by generating formalin with a suitable lamp placed under the cloak.

THE DISEASE IN EUROPE AND PREVIOUS OUTBREAKS IN AMERICA.

Foot-and-mouth disease has appeared so seldom in the United States and the outbreaks have been so small that the great losses which it may cause are not appreciated in this country, simply because the people have not experienced an outbreak of sufficient magnitude to observe its effects. There has consequently been some surprise expressed that such a radical measure as slaughter was adopted, and there has been an effort to show that the disease is mild and causes only slight losses. The promulgation of such views, even though they were founded upon ignorance of the disease, had the effect of arousing a certain amount of opposition to the work, hindering its progress, and to a certain extent jeopardizing its success. As the contagion is now in this country, it is well that the American farmers should understand the losses which are caused by foot-and-mouth disease and the measures which have been found necessary to control it in other countries. Most veterinary text-books state that foot-and-mouth disease is a mild affection, and that only 1 or 2 per cent of the animals attacked die from it, the reader being left to infer that the losses do not exceed 2 or 3 per cent of the value of the animals. Such a conclusion, however, would be a very grave mistake.

This disease has been known to the veterinarians and agriculturists of Europe since the time when, with advancing medical knowledge, it was possible to discriminate between the different plagues of animals. It has been more or less constantly present in the countries of Europe, and has been particularly prevalent on the Continent. Dr. A. C. Cope,[a] chief veterinary officer of the British board of agriculture, speaking in the year 1900 of its ravages in Great Britain, says:

> The disease was seen and recognized in 1839, and continued with more or less prevalence until 1886. It was reintroduced in 1892, and again appeared in the latter part of 1894. And now, after the lapse of an interval of nearly six years, the disease has again found its way into this country, despite the fact that the importation of animals from all countries in which foot-and-mouth disease was known to exist has been prohibited for a period of eight years.

In continental Europe the disease became seriously disseminated about 1886, and has continued its ravages until the present, notwithstanding the most stringent regulations which have been adopted.

There have been but a few outbreaks in America, the most extensive one being in 1870, when the contagion was introduced by way of

[a] Annual Reports of Proceedings under Diseases of Animals Acts, etc., for 1900. London, 1901. P. 4.

Canada and spread into the New England States and into New York. The type of the disease at that time appears to have been mild, and the dissemination of the contagion was quite easily arrested. About 1880 there were two or three lots of animals brought to the United States affected with this disease, but there was no extension from the animals originally affected. In 1884 there was a small outbreak at Portland, Me., caused by imported cattle, and the disease spread to a few herds outside of the quarantine station. Owing to the small number of animals affected and the limited area of territory covered by the disease, it was easily controlled by the ordinary measures of quarantine and disinfection.

RECENT INTRODUCTION OF THE DISEASE INTO THE UNITED STATES.

It is not definitely known how the contagion was introduced into the United States in 1902, but the first herds affected were in Chelsea, Mass., in the vicinity of the docks, to which place the infection was no doubt carried from shipping. There are numerous channels by which it could have been introduced from Europe, where it has been very prevalent during the last fifteen or twenty years. Horses are continually being imported, with halters, ropes, forage, and bedding; small animals, such as goats, are often upon the ships, and fresh hides are also a constant article of commerce, and may come without sufficient disinfection from countries in which the disease exists. There are also imported large quantities of hair, wool, and other articles which might bring the contagion. As all cattle, sheep, and swine imported from European countries are placed in quarantine from fifteen to ninety days, it is impossible that the disease could have been brought with these animals without being recognized before they left the quarantine station.

STUDY OF THE DISEASE AND LOSSES BY IT IN EUROPE.

During the many years that the disease has been known in Europe there has been abundant opportunity to study its characters and to become familiar with the losses which it causes, and it may be fairly said that this disease is now dreaded more than any other which affects the farmers' live stock. Even in the mildest outbreaks, when but 1 or 2 per cent of the grown animals die from it, there are numerous other sources of loss which are much more important than the actual mortality. The fever and the difficulty of masticating the food cause a rapid and extreme loss in flesh and the cessation of the milk secretion. The udders often become inflamed and ruined by the formation of abscesses; the inflammation of the feet may cause the horn to drop from the toes, producing great lameness and permanently injuring the animals; while abortion is frequent with pregnant animals. Altogether this causes a loss of 20 to 30 per cent of the value of the cattle. The disease generally spreads to sheep and hogs, causing proportionately severe losses with these animals.

The type of the disease varies, however, probably more than with any other malady affecting the domestic animals, and in some outbreaks it is extremely malignant. Fleming[a] said in 1875 that it had been calculated that in recent invasions of the disease in Great Britain the average loss by death in those localities where it was very severe was 10 per cent, and Professor Brown stated that in one dairy in London 16 died out of 86.

Friedberger and Fröhner[b] state that sometimes the character of the disease is so malignant that 5 to 50 per cent of adult animals die and 50 to 80 per cent of the sucklings. The latter often die very rapidly, especially during the first few days after birth, while animals that are inclined to be weak and poorly nourished very frequently succumb.

Dr. Cope[c] stated at the International Veterinary Congress at Baden Baden, 1899:

It is true that foot-and-mouth disease rarely assumes a fatal character, but the fact that nearly all classes of animals on the farm are susceptible renders the indirect losses much greater in the case of foot-and-mouth disease than rinderpest or pleuro-pneumonia, which only affect cattle. In my country, where it existed for at least fifty years, it has caused enormous loss and inconvenience, greater than that of all the other contagious diseases of animals combined.

* * * * * * *

We have now been free from the disease since 1894, and I can assert that at the present time foot-and-mouth disease is more dreaded by the farmers and stock owners of Great Britain than cattle plague or pleuro-pneumonia, and they are now willing and ready to put up with any restrictions, of however drastic a character, considered necessary by the central department to stamp it out.

* * * * * * *

In fact, there are notable instances on record in which the breeding of pure-bred stock was abandoned. In many outbreaks where the disease appeared among the ewes, half of the lambs, and sometimes more, that were born at the time when their mothers were affected, died of the disease.

Hafner,[d] of Karlsruhe, gave an equally serious account of the ravages of the disease in southern Germany. He said foot-and-mouth disease had prevailed almost continually in Germany for a long series of years, and it had caused losses much greater than all other epizootic diseases combined. It had also been found that the disease, instead of following a benign course as formerly, had, during recent years, become very malignant. In fact, in numerous sections hundreds of cattle had suddenly died and certain estates had lost from a third to a half of their stock.

These observations of men who have studied the disease for years where it has been almost constantly present, show what disastrous

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[a] George Fleming: A Manual of Veterinary Sanitary Science and Police. London, 1875. Vol. I, p. 466.

[b] Friedberger and Fröhner: Lehrbuch der Speciellen Pathologie und Therapie der Hausthiere. Stuttgart, 1900. Vol. II, p. 682.

[c] Seventh International Congress of Veterinary Surgeons. Baden Baden, 1899. Vol. I, pp. 184, 187.

[d] Ibid., Vol. I, p. 350.

losses it causes and what a calamity it would be to a country like the United States to have the contagion spread over the whole extent of its territory. Not only would the immediate losses be tremendous, but the disease might linger on this continent, as it did in Great Britain, for half a century. To guard against such a calamity the most severe and rigid measures would be justified.

MEASURES FOR COMBATING THE DISEASE IN EUROPE.

ISOLATION AND QUARANTINE.

In Europe the disease has usually been combated by isolation and quarantine. But these measures have not been effective, as is shown by the continuous existence and the wide dissemination of the contagion. In considering the question as to whether quarantine would be practicable, it is well to inquire how long animals may spread the disease after they are affected by it. Hess, of Berne, at the Baden Baden Congress of 1899, contributed some observations of great interest in this connection.[a] He said that with 370 cattle affected with foot-and-mouth disease in the autumn of 1898 on the pastures of the Bernese Oberland, 7 of them, or nearly 2 per cent, propagated the disease in the course of the winter. From this he concluded that all cattle which recovered from foot-and-mouth disease should be, if possible, held in quarantine for five months, and that the owners of recovered cattle should not introduce new animals into their stables during this period of quarantine.

It has often been observed that cattle with chronic ulcers of the feet disseminate the disease a considerable time after they have apparently recovered; but this observation made by Hess, that recovered animals are only safe after a period of five months, makes the holding of diseased animals for recovery a much more serious matter than has heretofore been suspected. While diseased animals are alive they are constantly giving off the contagion by the saliva which escapes from the mouth and by the serum and pus which is excreted from the vesicles and ulcers of the udder and feet, and perhaps in other ways. While such animals are alive the stables are saturated with the contagion, and all persons or animals that leave such stables carry the contagion with them. When the animals are killed and the carcasses properly disposed of, the multiplication of this contagion ceases, and by ventilation and standing empty the stables become less and less infected, while if they are thoroughly disinfected with proper chemicals the danger of the disease spreading from them is arrested. There is probably no disease which is spread more easily than foot-and-mouth disease, and possibly none which is spread so easily, and it has in many cases been found impossible to stop its spread by quarantine measures.

[a] Seventh International Congress of Veterinary Surgeons. Baden Baden, 1899. Vol. I, pp. 404, 405.

Dammann,[a] of Hanover, at the Baden Baden congress, said that without an absolute quarantine of the infected farms, preventing even the movement of persons, the control of foot-and-mouth disease is not to be thought of; but this measure, he says, can not be executed. He further said that the very severe requirements of the sanitary law have not succeeded in eradicating the disease; and notwithstanding the quarantine of the infected stables, reinforced in many States by the quarantine of districts and often of a large zone around these; notwithstanding the very extended prohibition of animal markets and the supervision exercised over the abattoirs, dealers' stables, and railroad cars, the disease continued to prevail.

Dr. Loeffler[b] at the same congress said:

> Foot-and-mouth disease is spreading more and more every year; and every year it costs the German Empire enormous sums. Necessary measures had been taken with the greatest care; suspected grounds had been closely quarantined; this measure had been extended to whole communes and even to entire districts; disinfection had been carefully carried out; and notwithstanding all this, the disease kept spreading.

Cope[c] said that one of the most remarkable features of an outbreak which occurred in England "was the sudden appearance of the disease in Edinburgh, which is 400 miles distant from London, there being no center between London and that city. Every effort to trace how the virus of the disease was carried entirely failed, but the discovery of the fact that foot-and-mouth disease was capable of being conveyed for so great a distance by mediate contagion was one of the causes which led the board of agriculture to decide that the time had arrived for prohibiting the landing of animals from the whole of Europe, every other precaution which had been previously adopted to prevent its reintroduction having failed."

Such sudden extensions of the disease, although not to this distance, have been common in all outbreaks, and have excited more or less comment and speculation as to how they have occurred. Undoubtedly, the contagion may be carried a long distance in the clothing of persons who have been near the animals, and Hecker has proved that the feathers of pigeons which had picked up their food among infected chaff were infectious twelve hours afterwards.[d] He also produced the disease in dogs, cats, and rabbits by inoculation.[e] In the Massachusetts outbreak it has been suspected that the disease was carried in some cases by pigeons and in others by dogs, cats, and rats. These observations serve to explain to a certain extent the mysterious transmission of the disease from farm to farm over several miles of intervening territory.

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[a] Seventh International Congress of Veterinary Surgeons. Baden Baden, 1899. Vol. I, pp. 270–272.

[b] Ibid., Vol. II, p. 109.

[c] Ibid., Vol. I, pp. 200–201.

[d] Ibid., Vol. II, p. 384.

[e] Ibid., p. 385.

SLAUGHTER OF DISEASED ANIMALS.

With a contagion which is so easily and frequently carried from farm to farm or from town to town, and in which efforts at control by quarantine have so generally failed, it becomes an important object to lessen the period of existence of the contagion as much as possible by slaughtering the diseased animals. In Europe slaughter has not usually been attempted, because the disease has been so widespread that this would necessitate the destruction of nearly the entire stock of cattle. However, slaughter has been frequently resorted to, and sometimes with marked success.

This disease was at one time taken to Australia. Fleming[a] says:

> There was really only one outbreak in Victoria among the cattle on two farms, into which it had been introduced by an imported bull. These cattle were destroyed and with them the disease.

Dr. Cope[b] speaks of a communication which he received from Dr. Bang, of Copenhagen, in which he says:

> Since 1876 we have had every year, once or twice, a case of foot-and-mouth disease. In all cases we killed the cattle, sheep, and swine on the farms, even if only one calf was attacked.

Hess,[c] of Berne, at the Baden Baden congress, gave as one of his conclusions that the most efficacious and most economical measure to adopt against foot-and-mouth disease in most cases consists in the slaughter of all the infected animals. "The diseased animals," he said, "should be destroyed completely, including the hides and hair, and the exposed slaughtered under police supervision."

In England slaughter has been resorted to quite frequently in recent years to stamp out the disease when first introduced. Cope,[d] speaking of an outbreak in that country, says "it was eventually stamped out in the county of Kent by the purchase, slaughter, and burial of several of the affected flocks." Again, he says:

> Later in the year, when the outbreaks were still further reduced in number, the privy council urged and succeeded in inducing some of the local authorities to stamp out the center of disease by slaughtering all the animals on the premises.[e]

With reference to the measures adopted, Cope[f] says:

> Speaking generally it may be said that the latter consisted of the maintenance of strict isolation of all centers of the disease, disinfection of all persons and

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[a] George Fleming: A Manual of Veterinary Sanitary Science and Police. London, 1875. Vol. I, p. 447.

[b] Annual Reports of Proceedings under Diseases of Animals Acts, etc., for 1900. London, 1901. P. 10.

[c] Seventh International Congress of Veterinary Surgeons. Baden Baden, 1899. Vol. I, pp. 391, 407.

[d] Ibid., Vol. I, p. 200.

[e] Ibid., p. 197.

[f] Ibid., p. 185.

substances moved out of infected places, and sometimes the slaughter of whole herds of cattle and flocks of sheep, and finally, in order to prevent the reintroduction of the disease from abroad, it became absolutely necessary to prohibit the landing of animals from every country in the world in which foot-and-mouth disease existed or whose sanitary laws and regulations are inadequate to keep the disease out of their country or to prevent the exportation to Great Britain of diseased or infected animals.

In his report for 1900, Cope[a] says:

This was the only outbreak which occurred in the county of Suffolk during the year, but the disease soon after appeared on some farms in Norfolk within a few miles of this center on the following dates: January 30, at Freethorpe; February 4, 8, 10, and 19, at Ormesby, Freethorpe, and at Reedham. In all these instances the whole of the animals of the farms were slaughtered immediately after the nature of the disease had been confirmed, under the direction of the officers of the board, who had been dispatched to the locality.

Further in the same report[b] it is said:

After the lapse of six weeks the disease reappeared in the month of September as far south as Melksham in Wilts. In this instance it spread from the first center to two neighboring farms. The nature of the disease reported by the local veterinary surgeon was confirmed by the board's own officials. The slaughter of all the cattle, sheep, and swine on the farms was immediately adopted, and since that date no further cases have been discovered in the west of England.

On October 5 a center was detected in the county of Stafford near Lichfield among some milch cows. The animals were examined at the request of the board by Mr. H. Olver, F. R. C. V. S., of Tamworth, a veterinarian of great experience, and his views as to the nature of the disease were confirmed by myself; the herd was killed as rapidly as possible.

* * * * * * *

Other outbreaks of foot-and-mouth disease were detected in Essex, in the immediate neighborhood of the former, on December 13, 15, and 18. Slaughter of all the animals on these farms was again rigorously enforced, but before it could be carried out 19 cattle on one farm and 14 on another fell with the disease.

The report of the assistant secretary of the animals division of the British Board of Agriculture for 1900 shows that slaughter of the animals was resorted to in 21 out of the 24 outbreaks of foot-and-mouth disease occurring in Great Britain during that year.[c]

Dr. Cope[d] says in his report for 1901:

However, on the 27th of January, 1901, a report was received of a suspected outbreak near Ipswich. The board immediately dispatched an expert to inquire into the nature of the disease, and he discovered after careful examination that 3 out of 39 head of cattle then on the premises were affected with foot-and-mouth disease in an unmistakable form, having vesicles not only in the mouth and on the feet but also upon the teats. * * * All the cattle on the farm were

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[a] Annual Reports of Proceedings under Diseases of Animals Acts, etc., for 1900. London, 1901. P. 6.

[b] Ibid., p. 8.

[c] Ibid., pp. 25–28.

[d] Annual Reports of Proceedings under Diseases of Animals Acts, etc., for 1901. London, 1902. Pp. 8, 9.

slaughtered with the utmost speed as soon as the nature of the disease had been confirmed.

Again, Dr. Cope[a] says:

The more recent experience in the administration of the foot-and-mouth disease order of the board has gone to prove that under the new system of stopping the movement of stock in widely extended areas, and of slaughtering in every instance where isolation can not be effectually carried out, a general outbreak of the disease can with certainty be arrested. This view is, I think, established by the fact that although the several centers discovered in 1900–1901 were very widely distributed in England and Wales, the measures adopted were so effectual that not a single case of foot-and-mouth found its way into a market, railway pen or truck, or into yards and lairs where animals are so frequently congregated by dealers prior to movement.

SLAUGHTER OF DISEASED ANIMALS INDORSED.

The above quotations are sufficient to show that the slaughter of diseased animals has been frequently adopted as a means of combating the disease in Europe, and that it has been more successful than any other measures. In fact, the International Veterinary Congress, held at Baden Baden in 1899, stated in one of its resolutions passed with reference to this disease that it was necessary to authorize slaughter and to establish uniform sanitary regulations.[b] It is plain that in Europe the failure of efforts to control the disease by quarantine and isolation is recognized, and that the slaughter of diseased animals is looked upon as the most efficacious measure that can be adopted. The disease has frequently been stamped out by this method when first introduced into a country. If slaughter is justified and recommended in Europe, where the disease so frequently occurs and is so prevalent, how much more is it to be recommended in a country like the United States, where it is confined to a very small territory and where there is such an enormous number of animals to be affected by it if it spreads beyond control.

CHARACTERISTICS OF THE DISEASE.

In general, foot-and-mouth disease begins with an elevation of temperature amounting to from 2° to 6° F. and the formation of vesicles in the mouth, upon the udder and teats, and on the feet. These vesicles are of various sizes, the epidermis being raised by a clear exudate, which soon escapes by the rupture of the membrane. The membrane covering the vesicles is torn away by abrasion of the parts, or hangs in shreds, leaving a raw, ulcerated surface, which is extremely sensitive. When the vesicles appear in the mouth there is considerable salivation, the saliva gathering in a white foam about the mouth and attracting the attention of the observer. This is one of

[a] Annual Reports of Proceedings under Diseases of Animals Acts, etc., for 1901. London, 1902. P. 13.

[b] Seventh International Congress of Veterinary Surgeons. Baden Baden, 1899. Vol. II, p. 518.

the first symptoms, and the salivation may be so abundant as to saturate the hay and floor in front of the affected animal. Affected cattle may also make a peculiar smacking sound with the mouth, which is no doubt due to the soreness of the tongue or adjacent parts. When the disease is severe the vesicles in the mouth may be as large as a silver dollar; sometimes the whole mucous membrane appears congested and the epithelium loosened. When the tongue has been seized by the inspector to hold it while examining the mouth, the membrane has sometimes been stripped off by his hand, leaving the organ raw and bleeding and causing the animal the most acute suffering.

When the vesicles appear about the feet the animals may be seen to raise and shake the posterior extremities in a manner which indicates the pain that they feel in the affected regions. Large vesicles appear upon the udder and teats which interfere seriously with milking and from which secretions issue which may contaminate the milk at the time it is drawn. There is often congestion of the mammary glands, with induration and the formation of abscesses.

The acute stage of the disease is generally terminated within a period of two weeks, after which time convalescence occurs with more or less rapidity, according to the conditions of existence and the extremes of temperature to which the animals are subjected.

LOSSES BY THE DISEASE.

The disease is not one which produces a high fatality. The average loss by death in European countries has been from 2 to 5 per cent. The actual losses of cattle owners are, however, much greater than this. The high fever causes a rapid loss of flesh, which loss is augmented by the fact that owing to the large vesicles and resulting ulcers in the mouth the animals are not able to masticate their food. On account of this loss of flesh their value is decreased from 20 to 25 per cent. At the same time the milk secretion almost disappears, and the owner loses all revenue from his animals for from four to six weeks.

When the animals have recovered from the acute form of the disease many of them are found to be more or less injured, some of them having lost the horn from their feet, others having ulcers of the feet which cause chronic lameness, a considerable proportion having abscesses in the udder which make them worthless for milk production, while numerous others abort and become emaciated and of little value. On the whole, it is probably not far from correct to estimate that in an outbreak such as the present one in the New England States the average loss on account of the disease equals 50 per cent of the value of the cattle affected.

However, there is no disease in which different outbreaks vary more in their virulence than foot-and-mouth disease. In some outbreaks the cattle suffer but little, scarcely an animal dies, and the contagion

spreads very slowly or dies out in a short time. In other outbreaks 50 per cent of the cattle may die, the disease is very contagious and spreads rapidly, and the contagion is carried long distances in the clothing of persons and in the hair of animals.

CONDITIONS IN MASSACHUSETTS.

In Massachusetts a number of herds were preserved which had the disease in a mild form and which had apparently recovered at the time the inspection was made. In about one-third of these cases the owners afterwards came in with the statement that a relapse had occurred with their animals; some were again affected with the formation of vesicles, and most of the others had abscesses in the udders, which made them unfit for milk production. At the time these cattle were slaughtered the udders of many of them were so distended with pus that they were ruptured as the animals fell, and discharged vast quantities of this liquid.

The present outbreak in Massachusetts has been a very virulent one. The disease has spread with extreme facility and has affected all of the cattle in the infected herds within a very few days, while the fever has been very high, the loss of flesh extreme, and the after results very unfavorable.

LIABILITY OF HUMAN BEINGS TO THE DISEASE.

The communication of the disease to people using the milk of diseased animals has been frequently reported in European outbreaks. With children especially the disease produced in this manner is quite serious and sometimes fatal. A few cases of this kind were reported during the Massachusetts outbreak, but they were not investigated, and it is not positively known that the disease affecting the people was identical with that of the cattle. In this outbreak the sale of milk was stopped as soon as the disease was found upon a place, and for that reason there was not the opportunity for the infection of mankind which exists when an outbreak is more extended and affects practically all the milk-producing animals of a country. However, people were advised to pasteurize the milk which they used, and thus avoid any possibility of infection.

NUMBER OF ANIMALS AFFECTED, NUMBER SLAUGHTERED, COMPENSATION PAID, ETC.

The tables on the next page, compiled to April 1, 1903, show the number of herds and animals found affected with foot-and-mouth disease, the number slaughtered, the compensation paid, etc. The difference between the number of cattle affected (4,175) and the number slaughtered (3,543) represents those that either died or recovered. Nearly all the recoveries were in the early cases where the disease had run its course before the work of slaughtering was begun or before those herds could be reached.

Cattle affected since beginning of outbreak.

State.	Herds.	Cattle.
Massachusetts	152	3,011
New Hampshire	29	446
Vermont	22	351
Rhode Island	17	367
Total	220	4,175

Animals slaughtered by United States Department of Agriculture.

State.	Herds.	Cattle.	Swine.	Sheep and goats.	Total animals.
Massachusetts	122	2,666	220	54	2,940
New Hampshire	29	446	36	69	551
Vermont	22	351	55	74	480
Rhode Island	6	80	8		88
Total	179	3,543	319	197	4,059

Appraised valuations and compensation paid for animals slaughtered.

State and animals.	Number.	Appraised value on health basis.	Average per head.	Net compensation (70 per cent).	Average per head.
MASSACHUSETTS.					
Cattle (not including calves)	2,563	$129,466.72	$50.51	$90,626.70	$35.36
Calves	103	818.79	7.95	573.15	5.56
All cattle	2,666	130,285.51	48.87	91,199.85	34.21
Swine	220	2,210.43	10.05	1,547.30	7.03
Sheep and goats	54	438.00	8.11	306.60	5.68
Total	2,940	132,933.94		93,053.75	
NEW HAMPSHIRE.					
Cattle (not including calves)	420	18,808.00	44.78	13,165.60	31.35
Calves	26	201.00	7.73	140.70	5.41
All cattle	446	19,009.00	42.62	13,306.30	29.83
Swine	36	264.50	7.35	185.15	5.14
Sheep	69	365.00	5.29	255.50	3.70
Total	551	19,638.50		13,746.95	
VERMONT.					
Cattle (not including calves)	301			9,348.00	31.06
Calves	50			590.00	11.80
All cattle	351			9,938.00	28.31
Swine	55			429.32	7.81
Sheep	74			325.75	4.40
Total	480			10,693.07	
RHODE ISLAND.					
Cattle (not including calves)	79	3,523.00	44.59	2,466.10	31.22
Calves	1	3.00	3.00	2.10	2.10
All cattle	80	3,526.00	44.08	2,468.20	30.85
Swine	8	65.00	8.12	45.50	5.69
Total	88	3,591.00		2,513.70	

Appraised valuations and compensation paid for animals slaughtered—Cont'd.

SUMMARY.

Animals.	Number.	Net compensation.	Average per head.
Cattle (not including calves)	3,363	$115,606.40	$34.38
Calves	180	1,305.95	7.26
All cattle	3,543	116,912.35	33.00
Swine	319	2,207.27	6.92
Sheep and goats	197	887.85	4.51
Total compensation paid		120,007.47	

APPENDIX.

SUMMARY OF INFORMATION ON VARIOUS SUBJECTS OF INTEREST TO THE FARMER.

CONTENTS.

APPENDIX.

ORGANIZATION OF THE DEPARTMENT OF AGRICULTURE.[a]

SECRETARY OF AGRICULTURE, James Wilson.

The Secretary of Agriculture is charged with the supervision of all public business relating to the agricultural industry. He makes such regulations for interstate traffic in live stock as may be necessary to prevent transmission of contagious diseases, and has charge of all interstate quarantine. He directs the admission or exclusion of live animals from foreign countries, and has charge of quarantine stations for importing cattle. He conducts the inspection and regulates the conditions of shipment of live stock and of meat products exported from American ports. He exercises advisory supervision over the agricultural experiment stations deriving support from the National Treasury.

ASSISTANT SECRETARY OF AGRICULTURE, Joseph H. Brigham.

The Assistant Secretary performs such duties as may be required by law or prescribed by the Secretary. He also becomes Acting Secretary of Agriculture in the absence of the Secretary. During the World's Fair at St. Louis and preparations therefor, he is the representative of the Department of Agriculture on the board in charge of Government exhibits and is chairman of that board.

CHIEF CLERK, Andrew Geddes.

The Chief Clerk has the general supervision of the clerks and employees; of the enforcement of the internal regulations of the Department; and of the buildings occupied by the Department of Agriculture.

APPOINTMENT CLERK, Joseph B. Bennett.

The Appointment Clerk is charged by the Secretary with the preparation of all papers involved in making appointments, transfers, promotions, reductions, furloughs, and removals, and with all correspondence of the Department with the United States Civil Service Commission. He receives all certificates issued by that Commission to the Department, and deals with all questions affecting positions in the classified service. He is custodian of the Department seal.

CHIEF OF SUPPLY DIVISION, Cyrus B. Lower.

The Supply Division has charge of purchases of supplies and materials paid for from the general funds of the Department.

BUREAUS, DIVISIONS, AND OFFICES.

WEATHER BUREAU (corner Twenty-fourth and M streets NW.).—*Chief*, Willis L. Moore; *Chief Clerk*, Henry E. Williams; *Professors of Meteorology*, Cleveland Abbe, F. H. Bigelow, Alfred J. Henry, Charles F. Marvin, Edward B. Garriott.

The Weather Bureau has charge of the forecasting of weather; the issue of storm warnings; the display of weather and flood signals for the benefit of agriculture, commerce, and navigation; the gauging and reporting of rivers; the maintenance and operation of seacoast telegraph lines, and the collection and transmission of marine intelligence for the benefit of commerce and navigation; the reporting of temperature and rainfall conditions for the cotton, rice, sugar, and other interests; the display of frost and cold-wave signals; the distribution of meteorological information in the interests of agriculture and commerce; and the taking of such meteorological observations as may be necessary to establish and

[a] The organization of the Department here given is in accordance with the act approved March 3, 1903, making appropriations for the fiscal year beginning July 1, 1903, and shows changes in personnel to April 1, 1903.

record the climatic conditions of the United States, or as are essential for the proper execution of the foregoing duties.

BUREAU OF ANIMAL INDUSTRY.—*Chief*, D. E. Salmon; *Assistant Chief*, A. D. Melvin; *Chief Clerk*, S. R. Burch; *Chief of Inspection Division*, A. M. Farrington; *Chief of Miscellaneous Division*, Richard W. Hickman; *Chief of Pathological Division*, John R. Mohler; *Chief of Biochemic Division*, E. A. de Schweinitz; *Chief of Dairy Division*, Henry E. Alvord; *Zoologist*, ——— ———; *In charge of Experiment Station*, E. C. Schroeder; *Editor*, George F. Thompson.

The Bureau of Animal Industry makes investigations as to the existence of contagious pleuro-pneumonia and other dangerous communicable diseases of live stock, superintends the measures for their extirpation, makes original investigations as to the nature and prevention of such diseases, and reports on the condition and the means of improving the animal industries of the country. It also has charge of the inspection of import and export animals, of the inspection of vessels for the transportation of export cattle, and of the quarantine stations for imported neat cattle; supervises the interstate movement of cattle, and inspects live stock and their products when offered for food consumption.

BUREAU OF PLANT INDUSTRY.—*Chief*, Beverly T. Galloway; *Pathologist and Physiologist, and Acting Chief in absence of Chief*, A. F. Woods; *Chief Clerk*, James E. Jones; *Botanist*, F. V. Coville; *Agrostologist*, W. J. Spillman; *Pomologist*, G. B. Brackett; *Horticulturist*, L. C. Corbett; *Editorial Clerk*, J. E. Rockwell; *Botanist in charge of Seed and Plant Introduction and Distribution*, A. J. Pieters.

The Bureau of Plant Industry studies plant life in all its relations to agriculture. It includes Vegetable Pathological and Physiological Investigations; Botanical Investigations and Experiments; Pomological Investigations; Grass and Forage Plant Investigations; Experimental Gardens and Grounds; the Arlington Experimental Farm; Congressional Seed Distribution; Seed and Plant Introduction; Tea Culture Experiments; and Investigation of Production of Domestic Sugar.

BUREAU OF FORESTRY (Atlantic Building, 928–930 F street NW.).—*Forester and Chief*, Gifford Pinchot; *Assistant Foresters*, Overton W. Price and George B. Sudworth, Otto Luebkert, and William L. Hall.

The Bureau of Forestry investigates methods and trees for planting in the treeless West, gives practical assistance to tree planters, and also to farmers, lumbermen, and others, in handling forest lands. It studies commercial trees to determine their special values in forestry, and also studies forest fires and other forest problems.

BUREAU OF CHEMISTRY (corner Fourteenth and B streets SW.).—*Chemist and Chief*, Harvey W. Wiley; *Chief, Food Laboratory*, W. D. Bigelow; *Chief, Sugar Laboratory*, G. L. Spencer; *Chief, Road-Material Laboratory*, L. W. Page; *Chief, Insecticide and Agricultural Water Laboratory*, J. K. Haywood; *Chief, Dairy Laboratory*, G. E. Patrick; *Chief, Soil and Fertilizer Analysis Laboratory*, C. C. Moore; *Chief, Drug Laboratory*, L. S. Kebler.

The Bureau of Chemistry makes investigations of the methods proposed for the analyses of soils, fertilizers, and agricultural products, and such analyses as pertain in general to the interests of agriculture. It can not undertake the analyses of samples of the above articles of a miscellaneous nature, but application for such analyses should be made to the directors of the agricultural experiment stations of the different States. The bureau does not make assays of ores nor analyses of minerals for other than agricultural purposes, except when related to general agricultural interests, nor analyses of water. The Bureau does the chemical work of some of the other Bureaus and Divisions of the Department and for other departments of the Government which apply to the Secretary of Agriculture for such assistance.

BUREAU OF SOILS (212–214 Thirteenth street SW.).—*Chief*, Milton Whitney; *Chief Clerk*, A. G. Rice; *Soil Physicist*, Lyman J. Briggs; *Soil Chemist*, Frank K. Cameron; *In charge United States Soil Survey*, Thos. H. Means; *In charge of Insular Soil Survey*, Clarence W. Dorsey; *In charge of Soil Management*, Franklin H. King; *Tobacco Expert*, George T. McNess.

The Bureau of Soils is intrusted with the investigation, survey, and mapping of soils; the investigation of the cause and prevention of the rise of alkali in the soil, and the drainage of soils; and the investigation of the methods of growing, curing, and fermentation of tobacco in the different tobacco districts.

DIVISION OF ENTOMOLOGY.—*Entomologist and Chief*, L. O. Howard; *Entomologist in charge of Experimental Field Work*, C. L. Marlatt; *Entomologist in charge of Breeding Experiments*, F. H. Chittenden; *Entomologist in charge of Forestry Investigations*, A. D. Hopkins; *Entomologist in charge of Apiculture*, Frank Benton; *Entomologist in charge of Cotton-Boll Weevil Investigations*, A. L. Quaintance; *Expert in Sericulture*, Miss H. A. Kelly; *Assistant Entomologist*, D. W. Coquillett.

The Division of Entomology obtains and disseminates information regarding injurious insects affecting field crops, fruits, small fruits, and truck crops, forest and forest products, and stored products; studies insects in relation to diseases of man and other animals and as animal parasites; experiments with the introduction of beneficial insects and with the fungus and other diseases of insects, and conducts experiments and tests with insecticides and insecticide machinery. It is further charged with the investigations in apiculture and sericulture. The information gained is disseminated in the form of general reports, bulletins, and circulars. A good deal of museum work is done in connection with the Department of Insects of the National Museum, and insects are identified for experiment stations and other public institutions and private individuals.

DIVISION OF BIOLOGICAL SURVEY.—*Biologist and Chief*, C. Hart Merriam; *Assistant Chief*, A. K. Fisher; *Assistant in charge of Game Preservation*, T. S. Palmer.

The Division of Biological Survey studies the geographic distribution of animals and plants, and maps the natural life zones of the country; it also investigates the economic relations of birds and mammals, and recommends measures for the preservation of beneficial and the destruction of injurious species. It is charged with carrying into effect the provisions of the Federal law for the importation and protection of birds and certain provisions of the law for the protection of game in Alaska.

DIVISION OF ACCOUNTS AND DISBURSEMENTS.—*Chief and Disbursing Clerk*, Frank L. Evans; *Assistant Chief* (in charge of Weather Bureau disbursements), A. Zappone; *Cashier*, Everett D. Yerby.

The Division of Accounts and Disbursements is charged with the adjustment of all claims against the Department; decides questions involving the expenditure of public funds; prepares estimates of appropriations needed, contracts for annual supplies, letters of authorization, leases, and agreements; issues requisitions for the purchase of supplies, requests for passenger and freight transportation; and attends to all business relating to the financial interests of the Department, including payments of every description.

DIVISION OF PUBLICATIONS.—*Editor and Chief*, Geo. Wm. Hill; *Associate Editor*, Joseph A. Arnold; *Assistant Editor*, B. D. Stallings; *Assistant in charge of Document Section*, R. B. Handy.

The Division of Publications exercises general supervision of the Department printing and illustrations, edits all publications of the Department (with the exception of those of the Weather Bureau), has charge of the printing and Farmers' Bulletin funds, and distributes all Department publications with the exception of those turned over by law to the Superintendent of Documents for sale at the price affixed by him; it issues in the form of press notices, official information of interest to agriculturists, and distributes to agricultural publications and writers notices and synopses of Department publications.

BUREAU OF STATISTICS.—*Statistician and Chief*, John Hyde; *Assistant Statistician*, Stephen D. Fessenden.

The Statistician collects information as to the condition, production, etc., of the principal crops and the status of farm animals through State agents, each of whom is assisted by a corps of local reporters, through separate corps of county, township, and cotton correspondents, through traveling agents, and through a special foreign correspondent, assisted by consular, agricultural, and commercial authorities. He records, tabulates, and coordinates statistics of agricultural production, distribution, and consumption, the authorized data of governments, institutes, societies, boards of trade, and individual experts; prepares special statistical bulletins upon agricultural subjects, and issues a monthly crop report for information of producers and consumers.

DIVISION OF FOREIGN MARKETS.—*Chief*, George K. Holmes; *Assistant Chief*, Frank R. Rutter.

The Division of Foreign Markets has for its object the extension of the agricultural export trade of the United States. It investigates the requirements of foreign markets, studies the conditions of demand and supply as disclosed by the records of production, importation, and exportation, inquires into the obstacles confronting trade extension, and disseminates, through printed reports and otherwise, the information collected.

LIBRARY.—*Librarian*, Josephine A. Clark; *Assistant Librarian*, Claribel R. Barnett.

The Librarian has charge of the Library and supervises the arrangement and cataloguing of books, the preparation of bibliographies and similar publications, and the purchase of new books.

OFFICE OF EXPERIMENT STATIONS.—*Director*, A. C. True; *Assistant Director and Editor of Experiment Station Record*, E. W. Allen; *Chief of Editorial Division*, W. H. Beal; *Chief of Division of Insular Stations*, W. H. Evans; *Special Agent, Alaska*, C. C. Georgeson; *Special Agent, Hawaii*, Jared G. Smith; *Special Agent, Porto Rico*, F. D. Gardner; *Chief of Nutrition Investigations*, W. O. Atwater; *Chief of Irrigation Investigations*, Elwood Mead; *Farmers' Institute Specialist*, John Hamilton; *Chief Clerk*, Mrs. C. E. Johnston.

The Office of Experiment Stations represents the Department in its relation to the experiment stations, which are now in operation in all the States and Territories, and directly manages the experiment stations in Alaska, Porto Rico, and Hawaii. It seeks to promote the interests of agricultural education and investigation throughout the United States. It collects and disseminates general information regarding the colleges and stations, and publishes accounts of agricultural investigations at home and abroad. It also indicates lines of inquiry of the stations, aids in the conduct of cooperative experiments, reports upon their expenditures and work, and in general furnishes them with such advice and assistance as will best promote the purposes for which they were established. In a similar way it aids in the development of the farmers' institutes throughout the United States. It is charged with investigations on the nutritive value and economy of human foods. It conducts investigations on the laws and institutions relating to irrigation in different regions, the use of irrigation waters, the removal of seepage and surplus waters by drainage, and the use of different kinds of power for irrigation and other agricultural purposes.

OFFICE OF PUBLIC ROAD INQUIRIES.—*Director*, Martin Dodge; *Assistant Director*, Maurice O. Eldridge.

The Office of Public Road Inquiries collects and disseminates information concerning the systems of road management throughout the United States, conducts investigations and experiments regarding the best method of road making, and prepares publications on these subjects.

APPROPRIATIONS FOR THE DEPARTMENT OF AGRICULTURE FOR THE FISCAL YEARS ENDING JUNE 30, 1901, 1902, AND 1903.

Object of Appropriation.	1901.	1902.	1903.
Salaries, Department of Agriculture	$326,680.00	$373,820.00	$465,500.00
Library, Department of Agriculture	5,000.00	7,000.00	8,000.00
Contingent Expenses, Department of Agriculture	37,000.00	37,000.00	[a] 43,000.00
Animal Quarantine Stations	50,000.00	25,000.00	----------
Collecting Agricultural Statistics	110,000.00	120,000.00	94,200.00
Botanical Investigations and Experiments	30,000.00	45,000.00	55,000.00
Entomological Investigations	22,500.00	[b] 28,513.18	45,500.00
Vegetable Pathological Investigations	28,000.00	60,000.00	110,000.00
Biological Investigations	17,500.00	20,000.00	28,000.00
Pomological Investigations	9,500.00	20,000.00	30,000.00
Laboratory, Department of Agriculture	28,500.00	24,500.00	60,500.00
Forestry Investigations	80,000.00	146,280.00	254,000.00
Experimental Gardens and Grounds, Department of Agriculture	20,000.00	20,000.00	25,000.00
Soil Investigations	25,000.00	91,000.00	130,000.00
Grass and Forage Plant Investigations	17,000.00	20,000.00	30,000.00
Agricultural Experiment Stations [for stations under Hatch act, $780,000 in 1901; $789,000, 1902; $796,000, 1903]	[c] 60,000.00	[c] 69,000.00	[c] 76,000.00
Nutrition Investigations	17,500.00	20,000.00	20,000.00
Public Road Inquiries	14,000.00	20,000.00	30,000.00

[a] Includes $6,000 deficiency. [b] Includes $3,013.18 deficiency.
[c] Expenses of Office of Experiment Stations.

Appropriations for the Department of Agriculture for the fiscal years ending June 30, 1901, 1902, and 1903—Continued.

Object of Appropriation.	1901.	1902.	1903.
Publications, Department of Agriculture	$105,000.00	[a] $188,000.00	[b] $204,000.00
Sugar Investigations	7,000.00	5,000.00	5,000.00
Purchase and Distribution of Valuable Seeds	170,000.00	270,000.00	270,000.00
Salaries and Expenses, Bureau of Animal Industry	1,000,000.00	[c] 1,040,000.00	[d] 1,650,000.00
Irrigation Investigations	50,000.00	50,000.00	65,000.00
Tea Culture Investigations	5,000.00	7,000.00	10,000.00
Arlington Experimental Farm	10,000.00	10,000.00	15,000.00
Plans for Building, Department of Agriculture	----------	5,000.00	----------
Foreign Market Investigations	----------	----------	6,500.00
Silk Investigations	----------	----------	10,000.00
Total	2,245,180.00	2,772,013.18	3,759,200.00
WEATHER BUREAU.			
Salaries, Weather Bureau	153,320.00	159,820.00	165,260.00
Fuel, Lights, and Repairs, Weather Bureau	9,000.00	9,000.00	10,000.00
Contingent Expenses, Weather Bureau	8,000.00	8,000.00	8,000.00
General Expenses, Weather Bureau	828,000.00	865,500.00	915,500.00
Meteorological Observation Stations	60,000.00	60,000.00	60,000.00
Building Addition to Weather Bureau Building, Washington	----------	46,000.00	50,000.00
Cables and Land Lines, Weather Bureau	----------	----------	40,000.00
Storm-warning Stations, Glenhaven and South Manitou Island, Mich., Weather Bureau	----------	----------	15,000.00
Total, Weather Bureau	1,058,320.00	1,148,320.00	1,263,760.00
Grand total	3,303,500.00	3,920,433.18	5,013,960.00

[a] Includes $15,000 deficiency, but does not include $300,000 for Yearbook and $150,000 in general fund.
[b] Includes $4,000 deficiency, but does not include $300,000 for Yearbook and $185,000 in general fund.
[c] Includes $40,000 deficiency.
[d] Includes $500,000 deficiency, emergency fund for foot-and-mouth disease.

AGRICULTURAL COLLEGES AND OTHER INSTITUTIONS IN THE UNITED STATES HAVING COURSES IN AGRICULTURE.[a]

States and Territories.	Name of institution.	Location.	President.
Alabama	Alabama Polytechnic Institute.	Auburn	C. C. Thach, M. A.
	Agricultural and Mechanical College for Negroes.	Normal	W. H. Councill, Ph. D.
Arizona	University of Arizona	Tucson	F. Y. Adams, M. A.
Arkansas	University of Arkansas	Fayetteville	H. S. Hartzog, LL. D.
	Branch Normal College	Pine Bluff	Isaac Fisher.
California	University of California	Berkeley	B. I. Wheeler, LL. D.
Colorado	The State Agricultural College of Colorado.	Fort Collins	B. O. Aylesworth, LL. D.
Connecticut	Conn. Agricultural College	Storrs	R. W. Stimson, M. A.
Delaware	Delaware College	Newark	G. A. Harter, Ph. D.
	State College for Colored Students.	Dover	W. C. Jason, M. A.
Florida	Florida Agricultural College	Lake City	T. H. Taliaferro, Ph. D.
	Florida State Normal and Industrial College.	Tallahassee	N. B. Young, M. A.
Georgia	Georgia State College of Agriculture and Mechanic Arts.	Athens	H. C. White, Ph. D.
	Georgia State Industrial College.	College	R. R. Wright.
Idaho	University of Idaho	Moscow	J. A. McLean, Ph. D.
Illinois	University of Illinois	Urbana	A. S. Draper, LL. D.
Indiana	Purdue University	Lafayette	W. E. Stone, Ph. D.
Iowa	Iowa State College of Agriculture and the Mechanic Arts.	Ames	E. W. Stanton.[b]
Kansas	Kansas State Agricultural College.	Manhattan	E. R. Nichols, M. A.
Kentucky	Agricultural and Mechanical College of Kentucky.	Lexington	J. K. Patterson, LL. D.
	State Normal School for Colored Students.	Frankfort	J. S. Hathaway, M. A., M. D.
Louisiana	Louisiana State University and Agricultural and Mechanical College.	Baton Rouge	T. D. Boyd, LL. D.

[a] Including only institutions established under the land-grant act of July 2, 1862.
[b] Acting.

Agricultural colleges and other institutions in the United States, etc.—Continued.

States and Territories.	Name of institution.	Location.	President.
Louisiana	Southern University and Agricultural and Mechanical College.	New Orleans	H. A. Hill.
Maine	The University of Maine	Orono	G. E. Fellows, Ph. D.
Maryland	Maryland Agricultural College.	College Park	R. W. Silvester.
Massachusetts	Massachusetts Agricultural College.	Amherst	H. H. Goodell, LL. D.
Michigan	Michigan State Agricultural College.	Agricultural College.	J. L. Snyder, Ph. D.
Minnesota	The University of Minnesota.	St. Paul	C. Northrop, LL. D.
Mississippi	Mississippi Agricultural and Mechanical College.	Agricultural College.	J. C. Hardy, M. A.
	Alcorn Agricultural and Mechanical College.	Westside	W. H. Lanier, B. A.
Missouri	The University of Missouri	Columbia	R. H. Jesse, LL. D.
	Lincoln Institute	Jefferson City	B. F. Allen, M. A.
Montana	The Montana College of Agriculture and Mechanic Arts.	Bozeman	J. Reid, B. A.
Nebraska	The University of Nebraska	Lincoln	E. B. Andrews, LL. D.
Nevada	Nevada State University	Reno	J. E. Stubbs, M. A., D. D.
New Hampshire	The New Hampshire College of Agriculture and the Mechanic Arts.	Durham	
New Jersey	Rutgers Scientific School (The New Jersey State College for the Benefit of Agriculture and the Mechanic Arts].	New Brunswick	Austin Scott, LL. D.
New Mexico	The New Mexico College of Agriculture and Mechanic Arts.	Mesilla Park	Luther Foster, M. S. A.
New York	Cornell University	Ithaca	J. G. Schurman, LL. D.
North Carolina	The North Carolina College of Agriculture and Mechanic Arts.	West Raleigh	G. T. Winston, LL. D.
	The Agricultural and Mechanical College for the Colored Race.	Greensboro	J. B. Dudley, M. A.
North Dakota	North Dakota Agricultural College.	Agricultural College.	J. H. Worst, LL. D.
Ohio	Ohio State University	Columbus	W. O. Thompson, D. D.
Oklahoma	Oklahoma Agricultural and Mechanical College.	Stillwater	A. C. Scott, LL. M.
	Agricultural and Normal University.	Langston	I. E. Page, M. A.
Oregon	Oregon State Agricultural College.	Corvallis	T. M. Gatch, Ph. D.
Pennsylvania	The Pennsylvania State College.	State College	G. W. Atherton, LL. D.
Rhode Island	Rhode Island College of Agriculture and Mechanic Arts.	Kingston	K. L. Butterfield, M. S.
South Carolina	Clemson Agricultural College	Clemson College	P. H. Mell, Ph. D.
	The Colored Normal, Industrial, Agricultural, and Mechanical College of South Carolina.	Orangeburg	T. E. Miller, LL. D.
South Dakota	South Dakota Agricultural College.	Brookings	J. W. Heston, LL. D.
Tennessee	University of Tennessee	Knoxville	C. W. Dabney, LL. D.
Texas	State Agricultural and Mechanical College of Texas.	College Station	D. F. Houston, D. Sc.
	Prairie View State Normal School.	Prairie View	E. L. Blackshear.
Utah	The Agricultural College of Utah.	Logan	W. J. Kerr, D. Sc.
Vermont	University of Vermont and State Agricultural College.	Burlington	M. H. Buckham, LL. D.
Virginia	The Virginia Agricultural and Mechanical College and Polytechnic Institute.	Blacksburg	J. M. McBryde, LL. D.
	The Hampton Normal and Agricultural Institute.	Hampton	H. B. Frissell, LL. D.
Washington	Washington Agricultural College and School of Science.	Pullman	E. A. Bryan, M. A.
West Virginia	West Virginia University	Morgantown	D. B. Purinton, LL. D.
	The West Virginia Colored Institute.	Institute	J. McH. Jones.
Wisconsin	University of Wisconsin	Madison	E. A. Birge, D. Sc.[a]
Wyoming	University of Wyoming	Laramie	E. E. Smiley, D. D.

[a] Acting.

AGRICULTURAL EXPERIMENT STATIONS OF THE UNITED STATES, THEIR LOCATIONS, DIRECTORS, AND PRINCIPAL LINES OF WORK.

Stations, locations, and directors.	Number on staff.	Number of teachers on staff.	Principal lines of work.
Alabama (College), Auburn: C. C. Thach [a]	13	8	Botany; soils; analyses of fertilizers and food materials; field and pot experiments; horticulture; plant breeding; diseases of plants; feeding experiments; diseases of animals; dairying.
Alabama (Canebrake), Uniontown: J. M. Richeson	3	....	Soil improvement; field experiments; horticulture; floriculture; diseases of plants; diseases of animals; dairying.
Alabama (Tuskegee), Tuskegee: G. W. Carver	11	7	Field experiments; horticulture; diseases of plants; animal industry; dairying.
Arizona, Tucson: R. H. Forbes	8	5	Chemistry; botany; field experiments; improvement of ranges; horticulture, including date-palm culture; feeding experiments; irrigation.
Arkansas, Fayetteville: R. L. Bennett	6	2	Chemistry of foods; field experiments; horticulture; plant breeding; diseases of plants; feeding experiments; diseases of animals.
California, Berkeley: E. W. Hilgard	31	14	Physics; chemistry and geographical distribution of soils; bacteriology; fertilizers; field crops; horticulture; botany; meteorology; technology of wine and olive oil, including zymology; beet-sugar chemistry; chemistry of foods and feeding stuffs; animal husbandry; entomology; dairying; drainage and irrigation; reclamation of alkali lands; plant introduction.
Colorado, Fort Collins: L. G. Carpenter	15	10	Chemistry; field experiments; horticulture; plant breeding; entomology; irrigation.
Connecticut (State), New Haven: E. H. Jenkins	16	....	Chemistry; analysis and inspection of fertilizers, foods, and feeding stuffs; inspection of Babcock test apparatus and nurseries; diseases of plants; forestry; field experiments; entomology.
Connecticut (Storrs), Storrs: L. A. Clinton [a]	14	11	Food and nutrition of man and animals; bacteriology of dairy products; field experiments; dairying.
Delaware, Newark: A. T. Neale	6	6	Chemistry; bacteriology; field experiments; horticulture; diseases of plants; feeding experiments; diseases of animals; entomology; dairying.
Florida, Lake City: T. H. Taliaferro	13	7	Feeding; field experiments; horticulture; feeding experiments; veterinary science; entomology.
Georgia, Experiment: R. J. Redding	7	1	Field experiments; horticulture; entomology; pig feeding; dairying.
Idaho, Moscow: H. T. French	8	7	Chemistry; physics; botany; field experiments; horticulture; entomology; feeding experiments.
Illinois, Urbana: E. Davenport	22	10	Chemistry; bacteriology; field experiments; horticulture; forestry; plant breeding; diseases of plants; diseases of animals; feeding experiments; entomology; dairying.
Indiana, Lafayette: Arthur Goss	10	7	Chemistry; pot and field experiments; horticulture; feeding experiments; diseases of plants and animals.
Iowa, Ames: C. F. Curtiss	21	14	Chemistry; botany; field experiments; horticulture; diseases of plants; feeding experiments; entomology; dairying.
Kansas, Manhattan: J. T. Willard	17	13	Soils; horticulture; plant breeding; field experiments; feeding and digestion experiments; diseases of animals; entomology; dairying; extermination of prairie dogs and gophers.

[a] Acting.

Agricultural experiment stations of the United States, etc.—Continued.

Stations, locations, and directors.	Number on staff.	Number of teachers on staff.	Principal lines of work.
Kentucky, Lexington: M. A. Scovell	16	....	Chemistry; soils; analysis of fertilizers, foods, and feeding stuffs; field experiments; horticulture; plant breeding; animal husbandry; diseases of plants; entomology; dairying.
Louisiana (Sugar), New Orleans: William C. Stubbs	....	....	Chemistry; bacteriology; soils and soil physics; field experiments; horticulture; sugar making; drainage; irrigation.
Louisiana (State), Baton Rouge: William C. Stubbs	26	41	Chemistry; geology; botany; bacteriology; soils; inspection of fertilizers and paris green; field experiments; horticulture; animal husbandry; diseases of animals; entomology.
Louisiana (North), Calhoun: William C. Stubbs	....	....	Chemistry; soils; fertilizers; field experiments; horticulture; feeding experiments; stock raising; dairying.
Maine, Orono: C. D. Woods	12	7	Chemistry; botany; analysis and inspection of fertilizers, concentrated commercial feeding stuffs, and creamery glassware; horticulture; diseases of plants; seed tests; food and nutrition of man and animals; poultry raising; marine invertebrates; diseases of animals; entomology; dairying.
Maryland, College Park: H. J. Patterson	15	8	Chemistry; soils; field experiments; horticulture; diseases of plants; feeding experiments; diseases of animals; entomology.
Massachusetts, Amherst: H. H. Goodell	19	8	Chemistry; meteorology; analysis and inspection of fertilizers and concentrated commercial feeding stuffs; inspection of creamery glassware and nurseries; field experiments; horticulture; electro-germination; diseases of plants; digestion and feeding experiments; diseases of animals; entomology; dairying.
Michigan, Agricultural College: C. D. Smith	16	7	Chemistry; bacteriology; soils; field experiments; horticulture; diseases of plants; feeding experiments; diseases of animals; entomology; stable hygiene.
Minnesota, St. Anthony Park, St. Paul: W. M. Liggett	14	11	Chemistry; soils; field experiments; horticulture; forestry; diseases of plants; food and nutrition of man; plant and animal breeding; feeding experiments; diseases of animals; entomology; dairying.
Mississippi, Agricultural College: W. L Hutchinson	10	6	Soils, fertilizers; field experiments; horticulture; animal husbandry; diseases of animals; entomology; dairying.
Missouri (College) Columbia: H. J. Waters	16	7	Chemistry; field experiments; horticulture; diseases of plants; feeding experiments; animal and plant breeding; diseases of animals; entomology; dairying; irrigation.
Missouri (Fruit), Mountain Grove: Paul Evans	4	....	Horticulture.
Montana, Bozeman: S. Fortier	9	6	Chemistry; meteorology; botany; field experiments; horticulture; feeding experiments; poultry experiments; entomology; irrigation.
Nebraska, Lincoln: E. A. Burnett	17	9	Chemistry; botany; meteorology; soils; field experiments; horticulture; diseases of plants; forestry; feeding and breeding experiments; diseases of animals; entomology; irrigation.
Nevada, Reno: J. E. Stubbs	10	6	Chemistry; botany; soils; field experiments; horticulture; forestry; animal diseases; entomology; irrigation.
New Hampshire, Durham: F. W. Morse[a]	11	8	Chemistry; bacteriology; soil physics; draft and efficiency test of surface-working implements; field experiments; horticulture; diseases of plants; feeding experiments; entomology.
New Jersey (State), New Brunswick: E. B. Voorhees	12	2	Chemistry; biology; botany; analysis of fertilizers, foods, and commercial feeding stuffs; pot and field experiments; horticulture; diseases of plants; food and nutrition of man; diseases of animals; entomology; dairy husbandry; soil bacteriology; irrigation.
New Jersey (College), New Brunswick: E. B. Voorhees	7	4	
New Mexico, Mesilla Park: Luther Foster	11	7	Chemistry; botany; soils; field experiments; horticulture; feeding experiments; entomology; irrigation.

[a] Vice-director.

Agricultural experiment stations of the United States, etc.—Continued.

Stations, locations, and directors.	Number on staff.	Number of teachers on staff.	Principal lines of work.
New York (State), Geneva: W. H. Jordan	24	....	Chemistry; bacteriology; meteorology; fertilizers; analysis and control of fertilizers; inspection of creamery glassware; field experiments; horticulture; diseases of plants; feeding experiments; poultry experiments; entomology; dairying; irrigation.
New York (Cornell), Ithaca: I. P. Roberts	13	15	Chemistry of soils, feeding stuffs, and dairy products; soils; fertilizers; field experiments; horticulture; diseases of plants; feeding experiments; diseases of animals; poultry experiments; entomology; dairying.
North Carolina, Raleigh: B. W. Kilgore	12	6	Chemistry; soils; field experiments; horticulture; plant diseases; animal husbandry; diseases of animals; poultry experiments; dairying.
North Dakota, Agricultural College: J. H. Worst	7	10	Field experiments; plant breeding; horticulture; diseases of plants; food analysis; feeding experiments; diseases of animals; dairying.
Ohio, Wooster: C. E. Thorne	15	....	Soils; field experiments; horticulture; plant breeding; diseases of plants; breeding and feeding experiments; diseases of animals; entomology.
Oklahoma, Stillwater: John Fields	9	6	Chemistry; field experiments; horticulture; forestry; botany; diseases of plants; animal husbandry; diseases of animals; entomology.
Oregon, Corvallis: J. Withycombe	11	7	Chemistry; bacteriology; soils; field crops; horticulture; diseases of plants; feeding experiments; entomology; dairying.
Pennsylvania, State College: H. P. Armsby	14	7	Chemistry; meteorology; analysis of fertilizers, foods, and feeding stuffs; horticulture; field experiments; feeding experiments; dairying.
Rhode Island, Kingston: H. J. Wheeler	11	3	Chemistry; meteorology; soils; analysis and inspection of fertilizers and feeding stuffs; field and pot experiments; horticulture; poultry experiments.
South Carolina, Clemson College: P. H. Mell[a]	17	12	Chemistry; analysis and control of fertilizers; field experiments; horticulture; plant breeding; diseases of plants; feeding experiments; veterinary science; entomology; dairying.
South Dakota, Brookings: J. W. Wilson	12	6	Soils; field experiments; plant breeding; diseases of plants and animals; animal husbandry; dairying; irrigation.
Tennessee, Knoxville: A. M. Soule	11	9	Chemistry; soils; fertilizers; field experiments; horticulture; seeds; weeds; diseases of plants; feeding experiments; entomology; dairying.
Texas, College Station: W. D. Gibbs	14	5	Chemistry; meteorology; soils; field experiments; horticulture; feeding experiments; diseases of animals; irrigation.
Utah, Logan: J. A. Widtsoe	15	9	Chemistry of soils and feeding stuffs; alkali soil investigations; meteorology; field experiments; horticulture; diseases of plants; cattle and sheep breeding; feeding experiments; dairying; poultry experiments; irrigation; arid farming.
Vermont, Burlington: J. L. Hills	11	6	Chemistry; botany; analysis and control of fertilizers and feeding stuffs; inspection of creamery glassware; field experiments; horticulture; diseases of plants; feeding experiments; dairying.
Virginia, Blacksburg: J. M. McBryde	11	6	Field crops; horticulture; bacteriology; feeding experiments; veterinary science; entomology; cider and vinegar making; ferments.
Washington, Pullman: E. A. Bryan	14	8	Chemistry; botany; bacteriology; soils; field experiments; horticulture; plant breeding; diseases of plants; feeding and breeding experiments; oyster culture; diseases of animals; entomology; dairying; irrigation.
West Virginia, Morgantown: J. H. Stewart	15	5	Chemistry; analysis and control of fertilizers; soils; field experiments; horticulture; inspection of orchards and nurseries; feeding experiments; poultry experiments; entomology.

[a] Acting.

Agricultural experiment stations of the United States, etc.—Continued.

Stations, locations, and directors.	Number on staff.	Number of teachers on staff.	Principal lines of work.
Wisconsin, Madison: W. A. Henry	17	14	Chemistry; bacteriology; soils; field experiments; horticulture; feeding experiments; dairying; drainage and irrigation.
Wyoming, Laramie: B. C. Buffum	8	8	Geology; botany; meteorology; waters; soils; range improvement; fertilizers; field experiments; food analysis; feeding experiments; entomology; irrigation.

STATE OFFICIALS IN CHARGE OF AGRICULTURE.

Secretary of Agriculture.

Pennsylvania	N. B. Critchfield	Harrisburg.

Commissioners of Agriculture.[a]

Alabama	J. C. Adams	Montgomery.
Arkansas	Frank Hill	Little Rock.
Florida	B. E. McLin	Tallahassee.
Georgia	O. B. Stevens	Atlanta.
Kentucky	I. B. Nall	Frankfort.
Louisiana	J. G. Lee	Baton Rouge.
Maine	A. W. Gilman	Augusta.
Montana	J. A. Ferguson	Helena.
New York	Chas. A. Wieting	Albany.
North Carolina	S. L. Patterson	Raleigh.
North Dakota	R. J. Turner	Bismarck.
South Carolina	A. P. Butler	Columbia.
Tennessee	Thos. H. Paine	Nashville.
Texas	Jefferson Johnson	Austin.
Virginia	Geo. W. Koiner	Richmond.
Washington	W. P. C. Adams	Olympia.

Secretaries of State boards of agriculture.

California	Harry Lowden[b]	Sacramento.
Colorado	A. M. Hawley	Fort Collins.
Connecticut	J. F. Brown	North Stonington.
Delaware	Wesley Webb	Dover.
Illinois	W. C. Garrard	Springfield.
Indiana	Chas. Downing	Indianapolis.
Iowa	J. C. Simpson	Des Moines.
Kansas	F. D. Coburn	Topeka.
Massachusetts	J. W. Stockwell[c]	Boston.
Michigan	Addison M. Brown	Agricultural College.
Missouri	George B. Ellis	Columbia.
Nebraska	Robt. W. Furnas	Brownville.
Nevada	Louis Bevier	Carson City.
New Hampshire	N. J. Bachelder	Concord.
New Jersey	Franklin Dye	Trenton.
North Carolina	T. K. Bruner	Raleigh.
Ohio	W. W. Miller	Columbus.
Oklahoma	J. B. Thoburn	Guthrie.
Oregon	M. D. Wisdom	Portland.

[a] In several States the duties of the Commissioner of Agriculture are joined with the care of other interests also, as of mining and labor.

[b] Acting.

[c] J. L. Ellsworth after July 1, 1903.

Secretaries of State boards of agriculture—Continued.

Rhode Island	George A. Stockwell	Providence.
South Dakota	Walter B. Dean	Yankton.
Vermont	C. J. Bell	East Hardwick.
West Virginia	J. O. Thompson	Charleston.
Wisconsin	John M. True	Madison.

Officials in charge of agriculture.

Hawaii		Honolulu.
Porto Rico	Wm. H. Elliott	San Juan.
Philippine Islands	F. Lamson-Scribner	Manila.

SECRETARIES OF STATE AGRICULTURAL SOCIETIES.

Connecticut	B. W. Collins.	Meriden.
Florida	H. E. Stockbridge	Lake City.
Georgia	M. V. Calvin	Augusta.
Louisiana	W. H. Dalrymple	Baton Rouge.
Massachusetts	Leander F. Herrick	Worcester.
Maine	Geo. H. Clarke	Auburn.
Minnesota	E. W. Randall	Hamline.
Montana	Francis Pope	Helena.
Nevada	Wm. Hy. Doane	Reno.
New York	Edw. A. Callahan	Albany.
North Carolina	Joseph E. Pogue	Raleigh.
Pennsylvania	J. P. Nissley	Hummelstown.
South Carolina	T. W. Holloway	Pomaria.
Tennessee	W. G. Sadler	Nashville.
Vermont	C. M. Winslow	Brandon.

SECRETARIES OF STATE FAIRS.

Arkansas	Geo. R. Brown	Little Rock.
Colorado	C. L. Russell	Durango.
Delaware	L. J. Foulke	Wilmington.
Florida	H. E. Stockbridge	Lake City.
Indiana	Charles Downing	Indianapolis.
Kentucky	M. W. Neal	Louisville.
Missouri	J. R. Rippey	Lancaster.
Nebraska	Robert W. Furnas	Brownville.
New Mexico	P. F. McCanna	Albuquerque.
New York	S. C. Shaver	Albany.
North Dakota	W. F. Lorin	Mandan.
Pennsylvania	A. A. Groman	Bethlehem.
South Carolina	Thos. W. Holloway	Pomaria.
Utah	Septimus W. Sears	Salt Lake.
Vermont	F. H. Chapman	Rutland.
West Virginia	George Hook	Wheeling.
Wisconsin	J. M. True	Madison.

OFFICERS OF LOUISIANA PURCHASE EXPOSITION, ST. LOUIS, 1904.

Hon. D. L. Francis, president, St. Louis, Mo.; Walter B. Stevens, secretary, St. Louis, Mo.; Col. J. H. Brigham, chairman government board and representative of Department of Agriculture, Washington, D. C.; Harry H. Brigham, assistant representative, Department of Agriculture exhibits, Washington, D. C.; F. J. V. Skiff, director of exhibits, St. Louis, Mo.; F. W. Taylor, chief department of agriculture, including horticulture, St. Louis, Mo.; F. D. Coburn, chief, section of live stock, St. Louis, Mo.

OFFICIALS IN CHARGE OF FARMERS' INSTITUTES.

Farmers' Institute Specialist, Department of Agriculture.

John Hamilton, Washington, District of Columbia.

State superintendents.

State.	Name of official.	Post-office.
Alabama	C. A. Cary, Alabama Polytechnic Institute	Auburn.
	G. W. Carver, Agricultural Experiment Station	Tuskegee.
Alaska	C. C. Georgeson, Agricultural Experiment Station	Sitka.
Arizona	R. H. Forbes, Agricultural Experiment Station	Tucson.
Arkansas	H. S. Hartzog, University of Arkansas	Fayetteville.
California	E. J. Wickson, University of California	Berkeley.
	D. T. Fowler, for Central and Northern California	Do.
	A. J. Cook, for Southern California	Claremont.
Colorado	B. O. Aylesworth, President State Agricultural College	Fort Collins.
Connecticut	J. F. Brown, Secretary State Board of Agriculture	W. Stonington.
	J. O. Noble, Secretary Connecticut Dairymen's Association.	Hartford.
	H. C. C. Miles, Secretary Connecticut Pomological Society.	Milford.
Delaware	Wesley Webb, Director of Farmers' Institutes	Dover.
	A. T. Neale, Superintendent for Newcastle County	Newark.
	S. H. Messick, Secretary for Sussex County	Bridgeville.
Florida	C. M. Conner, Agricultural College	Lake City.
Georgia	H. C. White, President State College of Agriculture	Athens.
	Harvie Jordan, Director of Farmers' Institutes	Monticello.
Hawaii	J. G. Smith, Agricultural Experiment Station	Honolulu.
Idaho	H. T. French, Agricultural Experiment Station	Moscow.
Illinois	A. B. Hostetter, Secretary and Superintendent of Farmers' Institutes.	Springfield.
Indiana	W. C. Latta, Agricultural Experiment Station	Lafayette.
Iowa	J. C. Simpson, Secretary State Board of Agriculture	Des Moines.
Kansas	D. H. Otis, Professor of Animal Industry, Ag'l College	Manhattan.
Kentucky	I. B. Nall, Commissioner of Agriculture	Frankfort.
Louisiana	J. G. Lee, Commissioner of Agriculture	Baton Rouge.
Maine	A. W. Gilman, Commissioner of Agriculture	Augusta.
Maryland	W. L. Amoss, Director Farmers' Institutes	Benson.
Massachusetts	J. W. Stockwell, Secretary State Board of Agriculture	Boston.
Michigan	L. R. Taft, Superintendent Farmers' Institutes	Agricultural College
Minnesota	O. C. Gregg, Superintendent Farmers' Institutes	Lynd.
Mississippi	J. C. Hardy, President Agricultural and Mechanical College.	Agricultural College.
Missouri	Geo. B. Ellis, Secretary State Board of Agriculture	Columbia.
Montana	S. Fortier, President College of Agriculture and Mechanic Arts.	Bozeman.
Nebraska	E. A. Burnett, Director Agricultural Experiment Station.	Lincoln.
Nevada	J. E. Stubbs, Director Agricultural Experiment Station.	Reno.
New Hampshire	N. J. Bachelder, Secretary State Board of Agriculture	Concord.
New Jersey	F. Dye, Secretary State Board of Agriculture	Trenton.
New York	F. E. Dawley, Director of Institutes	Fayetteville.
North Carolina	S. L. Patterson, Commissioner of Agriculture	Raleigh.
North Dakota	E. E. Kaufman, Secretary Farmers' Institute Board	Fargo.
Ohio	W. W. Miller, Secretary State Board of Agriculture	Columbus.
Oklahoma	J. B. Thoburn, Secretary Board of Agriculture	Guthrie.
Oregon	J. Withycombe, Vice-director Agricultural Experiment Station.	Corvallis.
Pennsylvania	A. L. Martin, Deputy Secretary of Agriculture	Harrisburg.
Porto Rico	W. H. Elliott, Director of Farmers' Institutes	San Juan.
Rhode Island	G. A. Stockwell, Secretary State Board of Agriculture	Providence.
South Carolina	J. S. Newman, Agriculturist Clemson Agr. College	Clemson College.
	Thos. E. Miller, President Agricultural and Mechanical College	Orangeburg.
Tennessee	T. H. Paine, Commissioner of Agriculture	Nashville.
Texas	J. H. Connell, President Texas State Institutes	Dallas.
Utah	W. J. Kerr, President Agricultural College	Logan.
Vermont	C. J. Bell, Secretary State Board of Agriculture	East Hardwick.
Virginia	G. W. Koiner, Commissioner of Agriculture	Richmond.
Washington	E. A. Bryan, Director Agricultural Experiment Station.	Pullman.
West Virginia	J. B. Garvin, Superintendent of Institutes	Charleston.
Wisconsin	G. McKerrow, Superintendent Farmers' Institutes	Madison.

NATIONAL ASSOCIATIONS OF FARMERS.

American Cane Growers' Association.

President, Chas. A. Farwell, New Orleans, La.; D. D. Colcock, New Orleans, La.

New England Tobacco Growers' Association.

President, Edmund Haloday, Suffield, Conn.; Secretary, S. C. Hardin, Glastonbury, Conn.

Interstate Cotton Growers' Association.

President, Harvie Jordan, Monticello, Ga.; Secretary, J. P. Allison, Concord, Ga.

Southern Nut Growers' Association.

President, G. M. Bacon, De Witt, Ga.; Secretary, J. F. Wilson, Poulan, Ga.

National Grain Growers' Association.

President, M. P. Moran, Graceville, Minn.; Secretary, J. C. Hanley, St. Paul, Minn.

Rice Association of America.

President, S. A. Knapp, Lake Charles, La.; Secretary, A. B. Allison, Crowley, La.

National Wool Growers' Association.

President, Francis E. Warren, Cheyenne, Wyo.; Secretary, W. G. Markham, Avon, N. Y.

Allied National Agricultural Societies of America.

President, J. C. Hanley, St. Paul, Minn.; Secretary, M. P. Moran, Graceville, Minn.

International Farmers' Union.

President, Angus McDonald, Merrill, Mich.; Secretary, Charles Darland, Merrill, Mich.

MISCELLANEOUS STATE ORGANIZATIONS.

Name of organization.	Secretary.	Post-office.
Arizona Wool Growers' Association	F. E. Pollock	Flagstaff.
California Grain Growers' Association	W. F. Ford	Davisville.
California Raisin Growers' Association	A. L. Sayer	Madera.
Hawaiian Sugar Planters' Association	W. O. Smith	Honolulu.
Illinois Seed Corn Breeders' Association	F. A. Warner	Sibley.
Indiana Wool Growers' Association	H. H. Keim	Ladoga.
Iowa Corn Growers' Association	N. J. Harris	Des Moines.
Louisiana Good Roads Association	John Dymond	Belair.
Louisiana Sugar Planters' Association	Reginald Dykers	New Orleans.
Minnesota Grain Growers' Association	Dennis Fitzpatrick	Waverly.
Nebraska Irrigation Association	Robert Oberfelder	Sidney.
Nebraska Sugar Beet Growers' Association	W. N. Nason	Omaha.
Nebraska Veterinary Medical Association	A. T. Peters	Lincoln.
New Mexico Wool Growers' Association	Geo. Arnot	East Lasvegas.
New York Association of County Agricultural Societies.	G. W. Harrison	Albany.
New York State Farmers' Congress	G. L. Flanders	Do.
New York State Fair Commission	S. C. Shaver	Do.
Ohio Wool Growers' Association	W. N. Cowden	Quaker City.
Tennessee (East) Farmers' Convention	A. M. Soule	Knoxville.
Texas Truck Growers' Association	J. G. Jones	San Antonio.
Texas Cotton Growers' Association	John Gurley	Calvert.
Utah Wool Growers' Association	E. H. Calliker	Salt Lake City.
Vermont Maple Sugar Makers' Association	A. A. Miles	Morrisville.
West Virginia Live Stock Association	C. C. Brown	Charleston.
West Virginia Sheep Breeders and Wool Growers' Association.	Jas. B. Beal	Wallsburg.
Wisconsin Butter Makers' Association	E. H. Farrington	Madison.
Wisconsin Tobacco Growers' Association	A. L. Fisher	Janesville.

IRRIGATION OFFICIALS AND ASSOCIATIONS.

State and Territorial irrigation officers.

States and Territories.	Name of official.	Post-office.
Arizona	F. P. Trott, commissioner	Phoenix.
Colorado	L. G. Carpenter, State engineer	Denver.
	James J. Armstrong, superintendent Division No. 1	Do.
	E. R. Chew, superintendent Division No. 2	Pueblo.
	Wesley Staley, superintendent Division No. 3	Hooper.
	E. D. Samain, superintendent Division No. 4	Durango.
	A. F. Reeves, superintendent Division No. 5	Montrose.
	P. F. Reinhardt, superintendent Division No. 6	Steamboat Springs.
Idaho	Wayne Darlington, State engineer	Boise.
Kansas	R. M. Wright, commissioner of forestry	Dodge City.
Nebraska	J. H. Mickey, governor [a]	Lincoln.
	F. N. Prout, attorney-general [a]	Do.
	G. D. Follmer, commissioner public lands [a]	Do.
	Adna Dobson, State engineer	Do.
	J. C. Stevens, assistant secretary	Do.
	H. O. Smith, under secretary for water division 1	Crawford.
	Page T. Francis, under secretary for water division 2	Do.
Nevada	A. C. Cleveland, governor [a]	Carson City.
	William Woodburn, attorney-general [a]	Do.
	E. D. Kelley, surveyor-general [a]	Do.
New Mexico	G. A. Richardson, president of commission	Roswell.
	G. W. Knaebel, secretary	Santa Fe.
	Frank Springer, commissioner	East Las Vegas.
	W. A. Hawkins, commissioner	Alamogordo.
	E. A. Miera, commissioner	Albuquerque.
	P. E. Harroun, engineer	Do.
South Dakota	James H. Sheppard, State engineer	Brookings.
Utah	A. F. Doremus, State engineer	Salt Lake.
Wyoming	Fred. Bond, State engineer [b]	Cheyenne.
	C. C. Carlisle, assistant State engineer	Do.
	Pitt Covert, superintendent Division No. 1	Do.
	Frank H. Stotts, superintendent Division No. 2	Sheridan.
	Lou Blakesley, superintendent Division No. 3	Ten Sleep.
	O. A. Hamilton, superintendent Division No. 4	Rock Springs.

[a] State board of irrigation. [b] State board of control.

STATE DAIRY OFFICIALS.

State.	Commissioner.	Post-office.
California	J. M. Thomas, Secretary	114 California street, San Francisco.
Colorado	T. L. Monson	Denver.
Connecticut	John B. Noble	Hartford.
Illinois	Alfred H. Jones	Room 1623 Manhattan Building, Chicago.
Indiana	J. N. Hurty (State Health Officer)	Indianapolis.
Iowa	H. R. Wright	Des Moines.
Massachusetts	P. M. Harwood, General Agent	136 State House, Boston.
Michigan	A. W. Smith	Lansing.
Missouri	Geo. B. Ellis	Columbia.
Minnesota	W. W. P. McConnell	St. Paul.
Nebraska	W. F. Thompson	Wood River.
New Jersey	George W. McGuire	Trenton.
New York	Charles A. Weiting	Albany.
North Dakota	E. C. Kaufman	Fargo.
Ohio	Horace Ankeney	Columbus.
Oregon	J. W. Bailey	Portland.
Pennsylvania	B. H. Warren	Harrisburg.
South Dakota	C. P. Sherwood	Desmet.
Utah	Moroni Heiner	Morgan City.
Washington	E. A. McDonald	Seattle.
Wisconsin	J. Q. Emery	Madison.

DAIRY ASSOCIATIONS.

Name of organization.	Secretary.	Post-office.
National Association of State Dairy and Food Departments.	R. M. Allen	Lexington, Ky.
National Dairy Union	Charles Y. Knight	154 Lake st., Chicago.
National Creamery Buttermakers' Association	E. Sudendorf	Elgin, Ill.
New England Milk Producers' Union	W. A. Hunter	10 Florence St., Worcester, Mass.
Five States Milk Producers' Association	H. T. Coon	Homer, N. Y.
California Creamery Operators' Association	W. H. Saylor	114 California street, San Francisco.
California Dairy Association	Samuel E. Watson	207 Sacramento st., San Francisco.
Dairymen's Association of Southern California	Horace G. Hamilton	211 N. Beaudry avenue, Los Angeles.
Connecticut Dairymen's Association	J. B. Noble	Hartford.
Connecticut Creamery Association	E. B. Little	Somers.
Georgia Dairymen's Association	M. L. Duggan	Sparta.
Idaho Dairy and Pure Food Association	A. E. Gibson	Caldwell.
Illinois State Dairymen's Association	George Caven	154 Lake st., Chicago.
Chicago Milk Shippers' Union	H. B. Farmer	92 La Salle st., Chicago.
Indiana State Dairy Association	H. E. Van Norman	Lafayette.
Iowa State Dairy Association	P. H. Keiffer	Strawberry Point.
Kansas State Dairy Association	T. A. Borman	505 Polk st., Topeka.
Maine Dairymen's Association	L. W. Dyer	Woodfords.
Massachusetts Creamery Association	A. M. Lyman	Montague.
Michigan Dairymen's Association	S. J. Wilson	Flint.
Michigan, Grand Traverse Dairymen's Association	C. L. Whitney	Traverse City.
Minnesota State Dairymen's Association	J. R. Morley	Owatonna.
Minnesota State Butter and Cheese Makers' Association.	E. R. Slater	Fairmont.
Missouri Dairymen's Association	C. H. Eckles	Columbia.
Nebraska Dairymen's Association	S. C. Bassett	Gibbon.
(N. H.) Granite State Dairymen's Association	Ivan C. Weld	Durham.
New Jersey State Dairy Union	G. L. Gillingham	Moorestown.
New York State Dairymen's Association	W. W. Hall	Gouverneur.
North Dakota State Dairymen's Association	E. E. Kaufman	Fargo.
Ohio State Dairymen's Association	D. A. Crowner	West Jefferson.
Oregon Dairymen's Association	F. L. Kent	Corvallis.
Pennsylvania Dairy Union	M. E. Conard	West Grove.
Creamery Association of E. Pennsylvania and vicinity.	George R. Meloney	1937 Market st., Philadelphia.
South Carolina	G. M. Davis	Clinton.
South Dakota Dairy and Buttermakers' Association	C. P. Sherwood	Desmet.
Texas Dairy and Live Stock Association	J. H. Tom	Georgetown.
Utah Dairymen's Association	C. Z. Harris	Richmond.
Vermont Dairymen's Association	F. L. Davis	North Pomfret.
Washington State Dairymen's Association	Mrs. E. Carmichael	Yakima.
Wisconsin Dairymen's Association	George W. Burchard	Fort Atkinson.
Wisconsin Cheesemakers' Association	U. S. Baer	Madison.
Wisconsin Buttermakers' Association	F. B. Fulmer	Ettrick.

NATIONAL LIVE STOCK ASSOCIATION.

President, John W. Springer, Denver; secretary, Charles F. Martin, Denver.

INTERNATIONAL LIVE STOCK EXPOSITION.

President, John A. Spoor, Chicago, Ill.; secretary, Mortimer Levering, Lafayette, Ind.

NATIONAL ASSOCIATION OF EXHIBITORS OF LIVE STOCK.

President, M. H. Gentry, Sedalia, Mo.; secretary, G. Howard Davison, Millbrook, N. Y.

PROTECTION AGAINST CONTAGION FROM FOREIGN CATTLE.

An act of Congress of August 28, 1894, prohibits the importation of cattle and cattle hides, but by the act of March 2, 1895, making appropriations for the Department of Agriculture, it is provided that the prohibition may be suspended by the President whenever the Secretary of Agriculture shall certify to the President what countries or parts of countries are free from contagious or infectious diseases of

domestic animals. The President, by proclamation of November 8, 1895, lifted the embargo with reference to Norway, Sweden, Holland, Great Britain, Ireland, the Channel Islands, and the countries of North, Central, and South America so as to admit cattle under sanitary regulations prescribed by the Secretary of Agriculture; also from all countries so as to admit hides under regulations prescribed by the Secretary of the Treasury.

STOCK BREEDERS' ASSOCIATIONS.[a]

CATTLE.

American Aberdeen-Angus Breeders' Association.—Thomas McFarlane, 17 Exchange avenue, Union Stock Yards, Chicago, Ill., secretary.

American Devon Cattle Club.—L. P. Sisson, Newark, Ohio, secretary.

American Galloway Breeders' Association.—R. W. Park, Union Stock Yards, Chicago, Ill., secretary.

American Guernsey Cattle Club.—William H. Caldwell, Peterboro, N. H., secretary.

American Hereford Cattle Breeders' Association.—C. R. Thomas, 260-263 Live Stock Exchange Building, Kansas City, Mo., secretary.

American Jersey Cattle Club.—J. J. Hemingway, No. 8 West Seventeenth street, New York, N. Y., secretary.

American Polled Durham Breeders' Association.—Fletcher S. Hines, Matoll Park, Ind., secretary.

American Shorthorn Breeders' Association.—John W. Groves, Union Stock Yards, Chicago, Ill., secretary.

American Sussex Association.—Overton Lea, Nashville, Tenn., secretary.

Ayrshire Breeders' Association.—C. M. Winslow, Brandon, Vt., secretary.

Brown Swiss Cattle Breeders' Association.—N. S. Fish, Groton, Conn., secretary.

Dutch Belted Cattle Association.—H. B. Richards, Easton, Pa., secretary.

Holstein-Friesian Association of America.—Frederick L. Houghton, Brattleboro, Vt., secretary.

Red Polled Cattle Club of America (incorporated).—J. McLain Smith, Dayton, Ohio, secretary.

HORSES.

American Association of Importers and Breeders of Belgian Draft Horses.—J. D. Conner, jr., Wabash, Ind., secretary.

American Breeders' Association of Jacks and Jennets.—J. W. Jones, Columbia, Tenn., secretary.

American Cleveland Bay Breeders' Association.—R. P. Stericker, Attica, N. Y., secretary.

American Clydesdale Association.—R. B. Ogilvie, 39 Exchange avenue, Union Stock Yards, Chicago, Ill., secretary.

American Hackney Horse Society.—A. H. Godfrey, room 50, Astor Court Building, West Thirty-fourth street, New York City, secretary.

American Percheron Horse Breeders and Importers' Association.—George W. Stubblefield, Union Stock Yards, Chicago, Ill., secretary.

American Saddle Horse Breeders' Association.—I. B. Nall, Louisville, Ky., secretary.

American Shetland Pony Club.—Mortimer Levering, Lafayette, Ind., secretary.

American Shire Horse Breeders' Association.—Charles Burgess, Wenona, Ill., secretary.

American Stud Book, Thoroughbred.—James E. Wheeler, 173 Fifth avenue, New York, N. Y., registrar.

American Suffolk Punch Horse Association.—Alex. Galbraith, Janesville, Wis., secretary.

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[a] Under the provisions of paragraph 473 of the act of July 24, 1897, any animal imported specially for breeding purposes shall be admitted free, provided that no such animal shall be admitted free unless pure-bred, of a recognized breed, and duly registered in the book of record established for that breed. The Secretary of the Treasury, upon the advice of the Secretary of Agriculture, issued June 22, 1899, regulations for the importation of animals under this law, and designated the recognized breeds and the books of record established for these breeds.

American Trotting Registry Association.—Wm. H. Knight, Ellsworth Building, 355 Dearborn street, Chicago, Ill., secretary.

French Coach Horse Society of America.—S. D. Thompson, Chicago, Ill., secretary.

German, Hanoverian, and Oldenburg Coach Horse Association of America.—J. Crouch, Lafayette, Ind., secretary.

National French Draft Association.—C. E. Stubbs, Fairfield, Iowa, secretary.

Select Clydesdale Horse Society of America.—E. Bennett, jr., Topeka, Kans., secretary.

The American Morgan Register.—Joseph Battell, Middlebury, Vt., treasurer.

The Oldenburg Coach Horse Association of America.—C. E. Stubbs, Fairfield, Iowa, secretary.

SHEEP.

American Cheviot Sheep Society.—F. E. Dawley, Fayetteville, N. Y., secretary. Number of registrations, 14,970; date of first entry, March 24, 1894. Registration fees: To members, 50 cents for lambs under 1 year; over 1 year, $1. Affiliated foreign society: The Cheviot Sheep Society of Great Britain, John Robson, Newton, Bellingham, Northumberland, England, secretary. Eligible to registry: Animals whose sires and dams are recorded in the books of the National Cheviot Sheep Society, the American Cheviot Sheep Breeders' Association (this society), or the affiliated British book.

American Cotswold Association.—F. W. Harding, Waukesha, Wis., secretary.

American Leicester Breeders' Association.—A. J. Temple, Cameron, Ill., secretary.

National Merino Sheep Register Association.—R. O. Logan, California, Mich., secretary.

American Oxford-Down Record Association.—W. A. Shafor, Hamilton, Ohio, secretary.

American Southdown Breeders' Association.—Frank S. Springer, Springfield, Ill., secretary.

American Shropshire Registry Association.—Mortimer Levering, Lafayette, Ind., secretary.

American Rambouillet Sheep Breeders' Association.—Dwight Lincoln, Milford Center, Ohio, secretary.

American Suffolk Association.—Geo. A. Franklin, Des Moines, Iowa, secretary.

Black Top Spanish Merino Sheep Breeders' Association.—R. P. Berry, R. F. D. 4, Washington, Pa., secretary.

Delaine Merino Sheep Breeders' Association.—J. C. McNary, Houstonville, Pa., recording secretary; J. H. Hamilton, Canonsburg, Pa., corresponding secretary.

Dickinson Merino Sheep Record Company.—H. G. McDowell, Canton, Ohio, secretary.

Dorset Horn Sheep Breeders' Association of America.—M. A. Cooper, Washington, Pa., secretary.

Hampshire-Down Breeders' Association of America.—Comfort A. Tyler, Nottawa, Mich., Secretary.

Improved Black-top Merino Sheep Breeders' Association.—L. M. Crothers, Crothers, Pa., secretary.

Improved Delaine Merino Sheep Breeders' Association.—Geo. A. Henry, Bellefontaine, Ohio, secretary.

Michigan Merino Sheep Breeders' Association.—E. N. Ball, Hamburg, Mich., secretary.

National Merino Sheep Breeders' Association.—R. O. Logan, California, Mich., secretary.

National Improved Saxony Sheep Breeders' Association.—John G. Clarke, R. F. D. 9, Washington, Pa., secretary.

National Lincoln Sheep Breeders' Association.—Bert Smith, Charlotte, Mich., secretary.

New York State American Merino Sheep Breeders' Association.—J. H. Earll, Skaneateles, N. Y., secretary.

Ohio Spanish Merino Sheep Breeders' Association.—Wesley Bishop, Troyton, Ohio, secretary.

Standard Delaine Spanish Merino Sheep Breeders' Association.—S. M. Cleaver, East Bethlehem, Pa., secretary.

Standard American Merino Register Association.—J. P. Ray, Hemlock, N. Y., secretary.

The Continental Dorset Club.—J. E. Wing, Mechanicsburg, Ohio, secretary.

United States Merino Sheep Breeders' Registry Association.—J. A. B. Walker, Mountair, Pa., secretary.

Vermont, The, Atwood Merino Sheep Club Register—George Hammond, Middlebury, Vt., secretary.

Vermont Merino Sheep Breeders' Association.—Ira L. Hamblin, Middlebury, Vt., secretary.

Hogs (Swine).

American Berkshire Association.—Frank S. Springer, 512 East Monroe street, Springfield, Ill., secretary.

American Duroc-Jersey Swine Breeders' Association.—A. V. Bradrick, Shelbyville, Ind., secretary.

American Essex Association.—F. M. Srout, McLean, Ill., secretary.

American Small Yorkshire Club.—G. W. Harris, 3409 Third avenue, New York, N. Y., secretary.

Cheshire Swine Breeders' Association.—B. B. Badger, Ouaquaga, N. Y., secretary.

Standard Chester White Record Association.—W. H. Morris, Indianapolis, Ind., secretary.

American Chester White Record Association.—Carl Freigau, Dayton, Ohio, secretary.

American Poland-China Record Company.—W. M. McFadden, West Liberty, Iowa, secretary.

Central Poland-China Record Association.—W. H. Morris, Indianapolis, Ind., secretary.

Ohio Poland-China Record Company.—Carl Freigau, Dayton, Ohio, secretary.

Standard Poland-China Record Association.—George F. Woodworth, Maryville, Mo., secretary.

Victoria Swine Breeders' Association.—H. Davis, Dyer, Ind., secretary.

Suffolk Swine Association.—W. F. Watson, Winchester, Ind., secretary.

National Duroc-Jersey Record Association.—R. J. Evans, El Paso, Ill., secretary.

The American Tamworth Swine Record Association.—E. N. Ball, Hamburg, Mich., secretary.

The American Yorkshire Club.—E. W. Wilcox, Hugo, Minn., secretary.

Goats, Hares, Dogs, etc.

American Kennel Club.—A. P. Vredenburgh, 55 Liberty street, New York, N. Y., secretary.

National Belgian Hare Club of America, Incorporated.—Roe E. Remington, Montclair, Colo., secretary.

The American Angora Goat Breeders' Association.—W. T. McIntire, 277 Live Stock Exchange, Kansas City, Mo.

Poultry Associations.

National and interstate organizations.

Name of organization.	Secretary.	Post-office.
American Dorking Club	Watson Westfall	Sayre, Pa.
American Buff Plymouth Rock Club	W. C. Denny	Buffalo, N. Y.
American Black Minorca Club	John A. Gamewell	Hackensack, N. J.
American Cochin Club	Arthur R. Sharp	Taunton, Mass.
National Exhibition Game and Game Bantam Club	W. W. Withee	La Crosse, Wis.
American Houdan Club	Thomas F. Rigg	Iowa Falls, Iowa.
American Leghorn Club	Geo. H. Burgott	Lawtons Station, N.Y.
American Plymouth Rock Club	H. P. Schwab	Rochester, N. Y.
American Indian Game Club	C. S. Whiting	Darien, N. Y.
Eastern White Wyandotte Club	W. E. Mack	Woodstock, Vt.
Minorca Club of Northwest	Dr. H. B. Fay	Minneapolis, Minn.
National Bantam Association	E. Latham	Flatbush, N. Y.
New England Light Brahma Club	G. W. Cromack	Stoneham, Mass.
National Poultry and Pigeon Association	Geo. E. Howard	Washington, D. C.
National Fanciers' Association	Fred L. Kinney	Morgan Park, Ill.
Boston Poultry Association	C. Minot Weld	131 Devonshire street Boston, Mass.
Wolverine P. P. and P. S. Association	Gus Williams	Bay City, Mich.
St. Louis Fanciers' Association	John A. Francisco	1201 Lincoln Tr. Bld., St. Louis, Mo.
Mid-Continental Poultry Association	F. M. Slutz	Kansas City, Mo.
Interstate Poultry Association	R. Horrocks	Falls City, Nebr.
Buffalo Poultry Association	E. C. Pease	Buffalo, N. Y.
Madison Square Garden (New York) Poultry and Pig Association.	H. V. Crawford	Montclair, N. J.
Northern Ohio Poultry and Pet Stock Association	F. R. Hunt	Cleveland, Ohio.
Buckeye Poultry Association	Geo. B. Wetzel	Dayton, Ohio.
Tri-State Poultry Association	J. A. McIntosh	East Liverpool, Ohio.
Pittsburg Fanciers' Club	A. P. Robinson	110 Second avenue, Pittsburg, Pa.
Piedmont Poultry Association	B. W. Getsinger	Spartanburg, S. C.
Nashville Poultry Association	J. M. Hopkins	Nashville, Tenn.
Tacoma Poultry Association	H. H. Collier	Tacoma, Wash.
Western Bantam Breeders' Association	A. E. Brown	Morgan Park, Ill.

Secretaries of State poultry associations.

State.	Secretary.	Post-office.
Colorado	Frank E. Kimball	Denver.
District of Columbia	Geo. E. Howard	Washington.
Illinois	Edward Craig	Albion.
Kansas	J. W. F. Hughes	Topeka.
Kentucky	Charles Hess	Louisville.
Louisiana	J. D. Schmidt	126 Carondelet street, New Orleans.
Michigan	John A. Grover	Concord.
Minnesota	R. Meili	St. Paul.
Missouri	C. W. Nuss	Tina.
Nebraska	L. P. Ludden	Lincoln.
New York	E. M. Santee	Cortland.
North Carolina	J. P. Kerr	Biltmore.
Ohio	W. A. Lott	Wooster.
Oklahoma	Sam M. Lyon	Guthrie.
Pennsylvania	Geo. C. Watson	State College.
Rhode Island	H. S. Babcock	Providence.
Texas	Mrs. A. McAnulty	Circleville.
Tennessee	M. D. Andes	Bristol.
Utah	D. Duncan	Salt Lake City.
Vermont	J. S. Eaton	Woodstock.
West Virginia	H. D. Correll	Morgantown.
Wisconsin	J. L. Herbert	Stevens Point.

STATE ASSOCIATIONS OF BREEDERS.

Name of organization.	Secretary.	Post-office.
California Angora Goat Breeders' Association	C. E. Bailey	San Jose.
California Pacific Coast Jersey Cattle Club	A. Maillard	San Geronimo.
California Jersey Breeders' Association of Southern California.	N. A. Chisholm	Santa Ana.
Colorado Cattle and Horse Growers' Association	Fred P. Johnson	Denver.
Connecticut Sheep Breeders' Association	John H. Wadhams	Goshen.
Illinois Live Stock Breeders' Association	Fred H. Rankin	Urbana.
Illinois Horse Breeders' Association	George Williams	Athens.
Illinois Cattle Breeders' Association	Samuel E. Prather	Springfield.
Illinois Cattle Feeders' Association	Charles F. Mills	Do.
Illinois Sheep Breeders' Association	Frank S. Springer	Do.
Illinois Swine Breeders' Association	Charles F. Mills	Do.
Indiana Amer. Tunis Sheep Breeders' Association	M. A. Bridges	Fincastle.
Iowa Improved Stock Breeders' Association	E. H. White	Estherville.
Iowa Swine Breeders' Association	Geo. S. Prine	Oskaloosa.
Kansas Improved Stock Breeders' Association	H. A. Heath	Topeka.
Kentucky Live Stock Breeders' Association	M. W. Neal	Louisville.
Kentucky Swine Breeders' Association	do	Do.
Kentucky Trotting Horse Breeders' Association	E. W. Shanklin	Lexington.
Missouri Horse Breeders' Association	J. R. Rippey	Lancaster.
Missouri Improved Live Stock Association	George B. Ellis	Columbia.
Missouri State Sheep Breeders' Association	L. E. Shattuck	Stanberry.
Nebraska Improved Live Stock Breeders' Association.	E. Z. Russell	Herman.
Nebraska Swine Breeders' Association	E. F. Fasset	Lincoln.
Ohio Jersey Cattle Club	A. T. Dempsey	Columbus.
Ohio Short Horn Breeders' Association	S. B. Stewart	Canal Winchester.
Ohio Horse Breeders' Association	Samuel Taylor	Grove City.
Ohio Merino Sheep Breeders' Association	Wesley Bishop	Troyton.
Oregon Live Stock Breeders' Association	M. D. Wisdom	Portland.
Pennsylvania Guernsey Breeders' Association	Wm. B. Harvey	West Grove.
Pennsylvania Jersey Cattle Club	E. H. Sibley	Franklin.
Pennsylvania Live Stock Breeders' Association	E. S. Bayard	Pittsburg.
Texas Cattle Raisers' Association	J. C. Loving	Fort Worth.
Utah Cattle Growers' Association	W. K. Walton	Salt Lake City.
Vermont Green Mt. Cotswold Sheep Association	A. A. Miles	Morrisville.
Vermont Merino Sheep Breeders' Association	I. L. Hamblin	Middlebury.
Vermont Shropshire Sheep Association	A. A. Miles	Morrisville.
West Virginia Live Stock Association	C. C. Brown	Charleston.
West Virginia Sheep Breeders and Wool Growers' Association.	James Beall	Wellsburg.
Wisconsin Live Stock Breeders' Association	W. L. Carlyle	Madison.
Wisconsin Short Horn Breeders' Association	C. D. Rosa	Beloit.

STATE VETERINARIANS AND LIVE-STOCK SANITARY OFFICERS.

ALABAMA:
- Dr. W. H. Sanders, Montgomery, State health officer.
- Dr. C. A. Cary, Auburn, professor of veterinary science.

ARIZONA:
- H. Harrison, Phoenix, secretary live stock sanitary commission.
- Dr. J. C. Norton, Phoenix, veterinarian.

ARKANSAS:
- Dr. R. R. Dinwiddie, Fayetteville, veterinarian to State experiment station.

CALIFORNIA:
- Dr. W. P. Matthews, Sacramento, secretary State board of health.
- Dr. Charles H. Blemer, Sacramento, State veterinarian.

COLORADO:
- B. H. Du Bois, Denver, president State veterinary sanitary board.
- Dr. J. N. Hall, State capitol, Denver, secretary State board of health.
- Dr. A. B. McCapes, Denver, State veterinary surgeon.
- E. McCrillis, capitol building, Denver, secretary State board of stock inspection commissioners.

CONNECTICUT:
- Dr. C. A. Lindsley, New Haven, secretary State board of health.
- Heman O. Averill, capitol, Hartford, commissioner for domestic animals.

DELAWARE:
- Dr. Alex. Lowber, secretary State board of health, Wilmington.
- Dr. H. P. Eves, instructor in veterinary science, Delaware College, Newark.

FLORIDA:
- Dr. Joseph Y. Porter, Key West, secretary State board of health.
- Dr. Chas. F. Dawson, Lake City, professor of veterinary science.

GEORGIA:
- O. B. Stevens, Atlanta, commissioner of agriculture.

IDAHO:
- J. C. Dressler, Boise City, State sheep inspector.

ILLINOIS:
- Dr. J. A. Egan, Springfield, secretary State board of health.
- Dr. C. P. Lovejoy, Princeton, State veterinarian.
- Charles E. Miller, Springfield, secretary board of live stock commissioners.

INDIANA:
- Dr. J. N. Hurty, Indianapolis, secretary State board of health.
- Dr. A. W. Bitting, Lafayette, State veterinarian.

IOWA:
- Dr. Paul O. Koto, Forest City, State veterinary surgeon.
- Dr. J. F. Kennedy, Des Moines, secretary State board of health.

KANSAS:
- Dr. N. S. Mayo, Manhattan, professor of veterinary science.
- Dr. Charles Lowry, Topeka, secretary State board of health.
- F. H. Chamberlain, Sedan, secretary live stock sanitary commission.

KENTUCKY:
- Dr. J. N. McCormack, Bowling Green, secretary State board of health.
- Dr. F. T. Eiseman, Louisville, State veterinarian.

LOUISIANA:
- Dr. Will R. Harman, New Orleans, secretary State board of health.
- Dr. W. H. Dalrymple, Baton Rouge, veterinarian to State experiment station.

MAINE:
- Dr. A. G. Young, Augusta, secretary State board of health.
- F. O. Beal, Bangor, cattle commissioner.
- John M. Deering, Saco, cattle commissioner.
- F. S. Adams, Bowdoinham, cattle commissioner.

MARYLAND:
- Dr. John S. Fulton, 10 South street, Baltimore, secretary State board of health.
- Dr. H. A. Meisner, Merchants' National Bank, Baltimore, chief veterinary inspector.
- Wade H. D. Warfield, Merchants' Bank Building, Baltimore, secretary live stock sanitary board.

MASSACHUSETTS:
- Dr. Samuel W. Abbott, Boston, secretary State board of health.
- Dr. Austin Peters, Boston, chief of cattle bureau of State board of agriculture.

MICHIGAN:
- Dr. Henry B. Baker, Lansing, secretary State board of health.
- Dr. F. C. Wells, Warren, State veterinarian.
- H. H. Hinds, Stanton, president State live stock sanitary commission.

MINNESOTA:
- Dr. C. E. Cotton, Minneapolis, veterinarian live stock sanitary board.
- Dr. M. H. Reynolds, St. Anthony Park, veterinarian live stock sanitary board.
- Dr. H. M. Bracken, St. Paul, Pioneer Press Bldg., secretary State board of health.

MISSISSIPPI:
- Dr. John F. Hunter, Jackson, secretary State board of health.
- Dr. J. C. Robert, Agricultural College, professor of veterinary science.

MISSOURI:
- Dr. William T. Morrow, Kansas City, secretary State board of health.
- Dr. D. F. Luckey, Columbia, State veterinarian.
- George B. Ellis, Columbia, secretary State board of agriculture.

MONTANA:
- Board of stock commissioners, one for each county.
- W. G. Preuitt, Helena, secretary live stock commission.
- John T. Murphy, Helena, president live stock commission.
- Dr. M. E. Knowles, Helena, State veterinarian.
- Dr. E. D. Nash, Helena, deputy State veterinarian.

NEBRASKA:
- Dr. W. A. Thomas, Lincoln, State veterinarian.
- H. R. Corbet, Lincoln, secretary State board of health.

NEVADA:
- Dr. W. H. Patterson, Reno, secretary State board of health.

NEW HAMPSHIRE:
- Dr. Irving A. Watson, Concord, secretary State board of health.
- N. J. Bachelder, Concord, secretary board of cattle commissioners.

NEW JERSEY:
- Dr. Henry Mitchell, Trenton, secretary State board of health.
- Franklin Dye, Trenton, secretary tuberculosis commission.

New Mexico:
- Dr. W. G. Hope, Albuquerque, secretary Territorial board of health.
- J. A. La Rue, East Las Vegas, secretary cattle sanitary board.
- Harry F. Lee, Albuquerque, secretary sheep sanitary board.

New York:
- Dr. William E. Johnson, Albany, secretary to the commissioner of health.
- Dr. Wm. Henry Kelly, Albany, consulting veterinarian.

North Carolina:
- Dr. Richard H. Lewis, Raleigh, secretary board of health.
- Dr. Tait Butler, Raleigh, State veterinarian.
- S. L. Patterson, Raleigh, commissioner of agriculture.

North Dakota:
- Dr. L. Van Es, Park River, chief State veterinarian.
- Dr. H. H. Healey, Michigan City, secretary board of health.

Ohio:
- Dr. J. C. Crossland, Zanesville, president state board of health.
- Dr. C. O. Probst, Columbus, secretary State board of health.
- W. W. Miller, Columbus, secretary board of live stock commissioners.
- Dr. Paul Fischer, Columbus, State veterinarian.
- (Board of agriculture is also live stock commission.)

Oklahoma:
- Z. E. Beemblossom, Guthrie, secretary live stock sanitary commission.
- Dr. E. E. Cowdrick, Enid, superintendent of board of health.

Oregon:
- Dr. William McLean, Portland, State veterinarian.

Pennsylvania:
- Dr. Benjamin Lee, 1532 Pine street, Philadelphia, secretary State board of health.
- Dr. Leonard Pearson, 3608 Pine street, Philadelphia, State veterinarian.

Rhode Island:
- Dr. Gardner T. Swarts, Providence, secretary State board of health.
- John S. Pollard, Providence, veterinarian State board of agriculture.

South Carolina:
- Dr. G. E. Nesom, Clemson College, State veterinarian.
- Dr. James Evans, Florence, secretary board of health.

South Dakota:
- Dr. T. W. Moffitt, Deadwood, secretary State board of health.
- Dr. J. P. Foster, Huron, State veterinary surgeon.
- Dr. O. W. Stanley, Sioux Falls, deputy State veterinary surgeon.

Tennessee:
- Dr. J. A. Albright, Somerville, secretary State board of health.
- Dr. J. W. Scheibler, 147 Court street, Memphis, State veterinarian.
- R. H. Kittrell, Nashville, State live stock inspector.

Texas:
- Dr. George R. Tabor, Austin, State health officer.
- Hon. R. J. Kleberg, Corpus Christi, secretary sanitary live stock commission.

Utah:
- Dr. T. B. Beatty, Salt Lake City, secretary State board of health.
- Prof. Lewis A. Merrill, Logan, professor of veterinary science.

Vermont:
- H. D. Holton, Brattleboro, secretary board of health.
- Victor I. Spear, Randolph, secretary cattle commission.

Virginia:
- Dr. Paulus A. Irving, Richmond, secretary board of health.
- Dr. J. G. Ferneyhough, Blacksburg, State veterinarian.

Washington:
- Dr. Elmer H. Heg, North Yakima, secretary board of health.
- Dr. S. B. Nelson, Pullman, State veterinarian experiment station.

West Virginia:
- Dr. A. R. Barbee, Point Pleasant, secretary State board of health.
- J. O. Thompson, Charleston, secretary board of agriculture.

Wisconsin:
- Dr. Evan D. Roberts, Janesville, State veterinarian.
- Dr. U. O. B. Wingate, Milwaukee, secretary board of health.

Wyoming:
- Dr. George T. Seabury, Cheyenne, State veterinarian.
- Ora Haley, president board of live stock commissioners.

STATE OFFICES FOR FOREST WORK.

CONNECTICUT.—State Forester, Walter L. Mulford, New Haven.
INDIANA.—State Board of Forestry, F. C. Carson, president, Michigan City, Ind.
KANSAS.—Commissioner of Forestry, R. M. Wright, Dodge City.
MAINE.—Land Agent and Forest Commissioner, Edgar E. Ring, Augusta.
MARYLAND.—State Geologic and Economic Survey, William B. Clark, State Geologist, Baltimore.
MICHIGAN.—Forestry Commission, Charles W. Garfield, president, Grand Rapids.
MINNESOTA.—Chief Fire Warden, Gen. C. C. Andrews, St. Paul.
Forest Commissioner, Samuel G. Iverson, St. Paul.
State Forestry Board, Sidney M. Owen, president, Minneapolis; Gen. C. C. Andrews, secretary, St. Paul.
NEW HAMPSHIRE.—Forest Commission, George H. Moses, secretary, Concord.
NEW JERSEY.—Geological Survey, Henry B. Kümmel, State Geologist, Trenton.
NEW YORK.—Forest, Fish, and Game Commission, Hon. D. C. Middleton, commissioner, Watertown.
Superintendent of State Forests.—William F. Fox, Albany.
NORTH CAROLINA.—Geological Survey, Prof. J. A. Holmes, State Geologist, Chapelhill.
OREGON.—Game and Forestry Warden, L. P. W. Quimby, Portland.
PENNSYLVANIA.—Department of Forestry, Dr. J. T. Rothrock, commissioner, Harrisburg.
State Forestry Reservation Commission, Isaac B. Brown, secretary.
WEST VIRGINIA.—Geologic and Economic Survey, Dr. I. C. White, superintendent, Morgantown.
WISCONSIN.—State Forest Warden, B. J. Castle, Madison.

FORESTRY ASSOCIATIONS.

NATIONAL ORGANIZATIONS.

American Forestry Association.—President, Hon. James Wilson, Secretary of Agriculture; secretary (corresponding), Edward A. Bowers, New Haven, Conn.

International Society of Arboriculture.—President, Gen. Wm. J. Palmer, Colorado Springs, Colo.; secretary, J. P. Brown, 1639 Michigan avenue, Chicago, Ill.

Society of American Foresters.—President, Gifford Pinchot, Washington, D. C.; secretary, Geo. B. Sudworth, Washington, D. C.

State organizations.

Name of organization.	Secretary.	Post-office.
Arizona. Salt River Valley Water-Supply Protective Association.	H. M. Chapman	Phœnix.
California Water and Forest Association	T. C. Friedlander	San Francisco.
California. Sierra Club	W. R. Dudley	Stanford University.
California. Forest and Water Society of Southern California.	William H. Knight	Los Angeles.
Colorado Forestry Association	Jabez Norman	Denver.
Connecticut Forestry Association	Miss Mary Winslow	Weatogue.
Massachusetts Forestry Association	Edwin A. Start	Boston.
Michigan Forest, Game, and Fish Protective Association.	R. P. Alden	Saginaw.
Minnesota State Forestry Association	T. L. Duncan	Bridgie.
Nebraska Park and Forest Association	L. D. Stutson	York.
New Hampshire. Society for the Protection of New Hampshire Forests.	Joseph T. Walker	Concord.
New York. Forestry, Water Storage and Manufacturing Association of the State of New York.	John C. Durgan	Sandy Hill.
New York State Fish, Game, and Forest League	E. G. Gould	Seneca Falls.
New York. Association for the Protection of the Adirondacks.	Henry S. Harper	Tribune Building, New York.
North Carolina Forestry Association	W. W. Ashe	Chapelhill.
North Dakota State Sylvaton Society	Miss Mary G. Buck	Lakota.
Oregon Forestry Association	Martin W. Gorman	Portland.
Oregon. Mazamas, The	do	Do.
Pennsylvania Forestry Association	Mrs. John P. Lundy	245 South Eighteenth Street, Philadelphia.
Pennsylvania. Franklin Forestry Society	W. G. Bowers	Chambersburg.
Tennessee Forest Association	L. C. Glenn	Vanderbilt University, Nashville.
Utah Forestry Association	A. C. Nelson	Salt Lake City.
Washington Forestry Association	Edmond S. Meany	Seattle.
Wyoming State Forest Association	W. C. Deming	Cheyenne.

SCHOOLS OF FORESTRY.

Yale University, Forest School, New Haven, Conn. A two-years' graduate course. In connection with the Yale Forest School, a two months' summer course, July and August, is conducted at Milford, Pa. Prof. Henry S. Graves, Director.

New York State College of Forestry at Cornell University, Ithaca, N. Y. A four-years' course. Practical instruction afforded by a demonstration area of 30,000 acres of State forest. Dr. B. E. Fernow, Director.

Biltmore Forest School, Biltmore, N. C. Course covers entire year; daily lectures in all branches of applied forestry, elements of botany, geology, law, and political economy; practical work on the domain of the Biltmore estate; forest investigations. Dr. C. A. Schenck, Director.

OFFICERS AND MEMBERS OF STATE BOARDS OF HORTICULTURE.

California State Board of Horticulture, 1903.—President, Ellwood Cooper, Santa Barbara; vice-president, Frank H. Buck, Vacaville; secretary and chief horticultural officer, J. J. Keegan, Sacramento; auditor and treasurer, Rus D. Stephens, Sacramento; quarantine officer and entomologist, Alexander Craw, San Francisco, district commissioners, M. J. Daniel, Riverside; Gerald Gerraldson, Newcastle; A. C. Eisen, Fresno; A. B. Cash, Santa Clara.

Colorado State Board of Horticulture, 1903.—President, W. S. Coburn, Hotchkiss; secretary, Mrs. Martha A. Shute, Denver; members, J. H. Crowley, Rocky Ford; S. A. Smith, Fort Morgan; G. E. Richardson, Alcott; J. R. Penniston, Whitewater.

Indiana State Board of Horticulture, 1903.—President, W. W. Stevens, Salem; secretary, W. B. Flick, Lawrence; treasurer, Sylvester Johnson, Irvington.

Montana State Board of Horticulture, 1903.—President, E. N. Brandegee, Helena; secretary, C. H. Edwards, Butte; district committeemen, C. H. Brandegee, C. H. Campbell, C. M. Allen, J. H. Edwards; ex officio, Gov. Joseph K. Toole, Helena.

Oregon State Board of Horticulture, 1903.—President, E. L. Smith, Hood River; secretary, Geo. H. Lamberson, Portland; treasurer, Lloyd T. Reynolds, Salem; commissioners, A. H. Carson, Grants Pass; R. H. Weber, The Dalles; Judd Geer, Cove.

Utah State Board of Horticulture, 1902.—President, Thomas Judd; vice-president, B. H. Bower; secretary, J. A. Wright, Salt Lake City.

HORTICULTURAL AND KINDRED SOCIETIES.

National organizations.

Name of organization.	Secretary.	Post-office.
American Association of Nurserymen	George C. Seager	Rochester, N. Y.
American Carnation Society	Albert M. Herr	Lancaster, Pa.
American Cranberry Growers' Association	A. J. Rider	Hammonton, N. J.
American Fruit Growers' Association	John C. Mangan	Bridge, Minn.
American Pomological Society	William A. Taylor	55 Q street NE., Washington, D. C.
American Rose Society	Leonard Barron	136 Liberty street, New York.
Chrysanthemum Society of America	Fred. H. Lemon	Richmond, Ind.
Cider and Cider-Vinegar Association of the Northwest.	George Miltenberger.	213 North Second street, St. Louis, Mo.
Eastern Nurserymen's Association	William Pitkin	Rochester, N. Y.
Farmers' Club of American Institute, Horticultural Section.	Leonard Barron	136 Liberty street, New York.
Mississippi Valley Apple Growers' Association	James Handly	Quincy, Ill.
Missouri Valley Horticultural Society	Harriet E. Chandler	R. R. No. 1, Argentine, Kans.
National Apple Shippers' Association	A. Warren Patch	17 N. Market street, Boston, Mass.
Northwest Fruit Growers' Association	Geo. H. Lamberson	Portland, Oreg.
Peninsula Horticultural Society	Wesley Webb	Dover, Del.
Society of American Florists and Ornamental Horticulturists.	William J. Stewart	79 Milk street, Boston, Mass.
Southern Nurserymen's Association	J. C. Hale	Winchester, Tenn.
Western Association of Wholesale Nurserymen	E. J. Holman	Leavenworth, Kans.

State organizations.

Name of organization.	Secretary.	Post-office.
Arkansas State Horticultural Society	Ernest Walker	Fayetteville.
California State Floral Society	Mrs. H. P. Tricou	814 Grove street, San Francisco.
Colorado State Horticultural Society	Charles L. Parsons	Boulder.
Connecticut Pomological Society	H. C. C. Miles	Milford.
Connecticut Horticultural Society	L. H. Mead	Hartford.
Florida State Horticultural Society	Stephen Powers	Jacksonville.
Georgia State Horticultural Society	W. M. Scott	Atlanta.
Idaho State Horticultural Society	Robert Milliken	Nampa.
Illinois State Horticultural Society	L. R. Bryant	Princeton.
Indiana Horticultural Society	W. B. Flick	Lawrence.
Iowa State Horticultural Society	Wesley Greene	Des Moines.
Kansas State Horticultural Society	William H. Barnes	Topeka.
Kentucky State Horticultural Society	J. C. Hawes	Buechel.
Maine State Pomological Society	D. H. Knowlton	Farmington.
Maryland State Horticultural Society	J. B. S. Norton	Collegepark.
Massachusetts Fruit Growers' Association	C. A. Whitney	Upton.
Massachusetts Horticultural Society	William P. Rich	300 Massachusetts avenue, Boston.
Michigan State Horticultural Society	C. E. Bassett	Fennville.
Minnesota State Horticultural Society	A. W. Latham	207 Kasota Block, Minneapolis.
Missouri State Horticultural Society	L. A. Goodman	4000 Warwick boulevard, Kansas City.
Montana State Horticultural Society	Mrs. Emma A. Ingalls	Kalispell.
Nebraska State Horticultural Society	C. H. Barnard	Tablerock.
New Hampshire Horticultural Society	W. D. Baker	Quincy.
New Jersey State Horticultural Society	Henry I. Budd	Mount Holly.
New Mexico Horticultural Society	Jose D. Sena	Santa Fe.
New York State Fruit Growers' Association	F. E. Dawley	Fayetteville.
(New York) Horticultural Society of New York	Leonard Barron	136 Liberty street, New York.
North Carolina State Horticultural Society	T. K. Bruner	Raleigh.
Ohio State Horticultural Society	E. M. Woodard	Kirtland.
Oklahoma Horticultural Society	J. B. Thoburn	Oklahoma City.
Oregon State Horticultural Society	E. R. Lake	Corvallis.
Pennsylvania Horticultural Society	David Rust	Horticultural Hall, Philadelphia.
Pennsylvania State Horticultural Association	Enos B. Engle	Waynesboro.
Rhode Island Horticultural Society	Charles W. Smith	27 Exchange street, Providence.
South Carolina State Horticultural Society	Charles E. Chambliss	Clemson College.
South Dakota State Horticultural Society	N. E. Hansen	Brookings.
Texas State Horticultural Society	Sam. H. Dixon	Houston.
Vermont Horticultural Society	D. C. Hicks	North Clarendon.
Virginia State Horticultural Society	Walter Whately	Crozet.
Washington State Horticultural Society	C. A. Tonneson	Tacoma.
West Virginia State Horticultural Society	S. W. Fletcher	Morgantown.
Wisconsin State Horticultural Society	J. L. Herbst	Sparta.
Wisconsin State Cranberry Growers' Association	W. H. Fitch	Cranmoor.

BEE KEEPERS' ASSOCIATIONS.

Name of organization.	Secretary.	Post-office.
National Bee Keepers' Association	Geo. W. York	Chicago, Ill.
California State Bee Keepers' Association	J. F. McIntyre	Sespe.
California Bee Keepers' Association	F. E. Wells	Selma.
Colorado Honey Producers' Association	Frank Rauchfuss	Denver.
Colorado State Bee Keepers' Association	H. C. Morehouse	Boulder.
Connecticut Bee Keepers' Association	Miss Ellen B. Peck	Clinton.
Idaho State Bee Keepers' Association	Miss B. M. Petersen	Lower Boise.
Illinois State Bee Keepers' Association	James A. Stone	R. F. D. 4, Springfield.
Indiana State Bee Keepers' Association	W. S. Pouder	Indianapolis.
Eastern Iowa Bee Keepers' Association	W. A. Hay	Anamosa.
Southeastern Kansas Bee Keepers' Association	J. C. Balch	Bronson.
Michigan State Bee Keepers' Association	E. B. Terrell	Davison.
Minnesota Bee Keepers' Association	L. D. Leonard	Minneapolis.
Missouri State Bee Keepers' Association	W. T. Cary	Wakenda.
Nebraska Bee Keepers' Association		
New Jersey Bee Keepers' Association	George N. Wanser	Cranford.
New York State Association of Bee Keepers' Societies.	C. B. Howard	Romulus.
New York State Bee Keepers' Association	J. H. Knickerbocker	Pleasant Valley.
Northeastern Ohio and Northwestern Pennsylvania Bee Keepers' Association.	Ed. Jolley	Franklin, Pa.

Bee keepers' associations—Continued.

Name of organization.	Secretary.	Post-office.
South Dakota State Bee Keepers' Association		
Southern East Tennessee Bee Keepers' Association	W. J. Copeland	Fetzerton.
Texas State Bee Keepers' Association	J. N. Hunter	Wylie.
Utah Bee Keepers' Association	T. N. Elliott	Salt Lake City.
Vermont Bee Keepers' Association	V. V. Blackmore	Orwell.
Washington State Bee Keepers' Association	L. R. Freeman	North Yakima.
Wisconsin State Bee Keepers' Association	Gus Dittmer	Augusta.

THE NATIONAL GOOD ROADS ASSOCIATION.

President, W. H. Moore; secretary, R. W. Richardson; treasurer, Edwin A. Potter. Address for general officers, 1128 Marquette Building, Chicago, Ill.

THE PROTECTION OF BIRDS AND GAME.

State and Provincial (Canadian) officials.

States, Territories, and Provinces.	Commissioner.	Post-office.
Arizona	T. S. Bunch	Safford.
California	Chas. A. Vogelsang, chief deputy.	Mills Building, San Francisco.
Colorado	John M. Woodard	Denver.
Connecticut	E. Hart Geer, secretary	Hadlyme.
Idaho	T. W. Bartley, warden	Moscow.
Illinois	A. J. Lovejoy	Roscoe.
Indiana	Z. T. Sweeney	Columbus.
Iowa	G. A. Lincoln, warden	Cedar Rapids.
Maine	L. T. Carleton, chmn	Augusta.
Maryland	Jno. W. Avirett, warden	Cumberland.
	Robt. H. Gilbert, chf. dep. warden.	Calvert and Lombard streets, Baltimore.
Massachusetts	Joseph W. Collins, chmn	Boston.
Michigan	Charles H. Chapman	Sault Ste. Marie.
Minnesota	S. F. Fullerton, ex. agt	St. Paul.
Missouri	A. J. D. Burford	Burfordville.
Montana	William F. Scott, warden	Helena.
Nebraska	Geo. B. Simpkins, chief deputy.	Lincoln.
New Hampshire	Chas. B. Clarke, secretary	Concord.
New Jersey	George Riley, chief game protector.	190 Broad street, Newark.
New York	J. Warren Pond, chief game protector.	Albany.
North Dakota	Ever Wagness, warden	Devils Lake.
Ohio	J. C. Porterfield, chief warden.	Columbus.
Oklahoma	J. A. Gould, warden	El Reno, Canadian Co.
Oregon	L. P. W. Quimby, warden	Portland.
Pennsylvania	Dr. Joseph Kalbfus, sec	Harrisburg.
Rhode Island	Dr. F. H. Peckham, jr., chairman.	Providence.
Utah	John Sharp	Salt Lake City.
Vermont	Henry G. Thomas	Stowe.
Washington	T. R. Kershaw, warden	Whatcom.
West Virginia	E. F. Smith, warden	Hinton.
Wisconsin	Henry Overbeck, jr., warden.	Madison.
Wyoming	D. C. Nowlin, warden	Big Piney.
British Columbia	F. S. Hussey, supt	Victoria.
Manitoba	C. Barber, warden	Winnipeg.
New Brunswick	L. B. Knight	St. John.
Newfoundland	E. C. Watson, deputy minister.	St. Johns.
Nova Scotia	George Piers, secretary	Halifax.
Ontario	Wm. Montagu Smith, chairman.	Strathroy.
Quebec	S. N. Parent, minister	Quebec.

National organizations.

Name of organization.	Secretary.	Post-office.
American Ornithologists' Union—Committee on Protection of North American Birds.	William Dutcher, chmn	525 Manhattan avenue, New York, N. Y.
Bird Protective Society of America	Edward C. Pease	28 Stafford Building, Buffalo, N. Y.
Boone and Crockett Club	C. Grant La Farge	5 Beekman street, New York, N. Y.
International Forest, Fish, and Game Association.	Frank J. Howell	184 Linden Park boulevard, Chicago, Ill.
League of American Sportsmen	Arthur F. Rice	155 Pennington avenue, Passaic, N. J.
National Game, Bird, and Fish Protective Association.	Charles E. Brewster	Grand Rapids, Mich.
National Sportsmen's Association	J. A. H. Dressel	320 Broadway, New York, N. Y.
North American Fish and Game Protective Association.	E. T. D. Chambers	Quebec.

Chief wardens of League of American Sportsmen.

States, Territories, and Provinces.	Chief warden.	Post-office.
Alaska		
Alabama		
Arizona	M. J. Foley	Jerome.
Arkansas	W. R. Blockson	Eureka Springs.
California	Dr. David Starr Jordan	Stanford University.
Colorado	A. Whitehead	303 Tabor Building, Denver.
Connecticut	F. P. Sherwood	Southport.
District of Columbia		
Florida	W. W. K. Decker	Tarpon Springs.
Georgia	J. J. Doughty	Augusta.
Idaho	L. A. Kerr	Kendrick.
Illinois	M. D. Ewell, M. D	59 Clark street, Chicago.
Indiana	F. L. Littleton	30½ East Washington street, Indianapolis.
Iowa	Carl Quimby	Des Moines.
Kansas	O. B. Stocker	Wichita.
Kentucky	Geo. C. Long	Hopkinsville.
Maine	Col. E. C. Farrington	Augusta.
Maryland	J. E. Tylor	Baltimore.
Massachusetts	Heman S. Fay	Hazleton Block, Marlboro.
Michigan	J. Elmer Pratt	341 South College avenue, Grand Rapids.
Minnesota	Dietrich Lange	2294 Commonwealth avenue, St. Paul.
Missouri	Bryan Snyder	725 Central Building, St. Louis.
Montana	Prof. M. J. Elrod	Missoula.
Nebraska	Fred E. Mockett	Lincoln.
Nevada	Dr. W. H. Cavell	Carson City.
New Hampshire	Dr. A. F. Barrett	Sentinel Building, Keene.
New Jersey	Percy Johnson	Bloomfield.
New Mexico	W. M. Borrowdale	Magdalena.
New York	John R. Fanning	Powers Building, Rochester.
North Dakota	Dr. W. D. Jones	Devils Lake.
Ohio	W. E. Gleason	Mitchell Building, Cincinnati.
Oklahoma	W. M. Grant	Oklahoma City.
Oregon	Robert F. Kelly	Box 188, The Dalles.
Pennsylvania	C. F. Emerson	189 North Perry street, Titusville.
Rhode Island	Zenas W. Bliss	49 Westminster street, Providence.
South Carolina	C. F. Dill	Greenville.
South Dakota	D. C. Booth	Spearfish.
Tennessee	Austin Peay, jr., sec	Clarksville.
Texas	Prof. S. W. Stanfield	Weatherford.
Utah	John Sharp	Salt Lake City.
Vermont	W. E. Mack	Woodstock.
Virginia	Franklin Stearns	13 North Eleventh street, Richmond.
Washington	F. S. Merrill	Spokane.
West Virginia	E. F. Smith	Hinton.
Wisconsin	Frank Kaufman	Two Rivers.
Wyoming	H. E. Wadsworth	Lander.
Ontario	C. A. Hammond	Box 701, St. Thomas.

State organizations.

Name of organization.	Secretary.	Post-office.
Arizona Sportsmen's Association	M. E. Cunningham	Bisbee.
Arkansas State Sportsmen's Association	Paul R. Litzke	Little Rock.
California Game and Fish Protective Association.	W. W. Richards	208 Golden Gate avenue, San Francisco.
[California] Cooper Ornithological Club	C. R. Keyes	Berkeley.
Connecticut Association for the Protection of Fish and Game.	George P. McLean	Simsbury.
Delaware Game Protective Association	J. Danforth Bush	Wilmington.
Game and Fish Protective Association of the District of Columbia.	Dr. W. P. Young	419 Tenth street NW., Washington.
Illinois Fish and Game Protective Association.	H. A. Sullivan	1510 Ashland Block, Chicago.
Illinois State Sportsmen's Association	Ed. Bingham	Chicago.
Iowa State Sportsmen's Association	L. D. Crissman	Ottumwa.
Kentucky Field Trials Club	Dr. F. W. Samuel	Louisville.
Kentucky Fish and Game Club	Hamilton Griswold	139 Third street, Louisville.
Maine Ornithological Society	Arthur H. Norton	Westbrook.
Maine Sportsmen's Fish and Game Ass'n	Col. E. C. Farrington	Augusta.
Maryland State Game and Fish Protective Association.	Oregon Milton Dennis	23 Chamber of Commerce, Baltimore.
Massachusetts Central Committee for the Protection of Fish and Game.	Henry H. Kimball	68 Devonshire street, Boston.
Mass. Fish and Game Protective Ass'n	Henry H. Kimball	Do.
Rod and Gun Club of Massachusetts	W. C. Thairlwall	95 South street, Boston.
Massachusetts Sportsmen's Association	Francis B. Crowinshield	Boston.
Michigan State Game and Fish Protective League.	R. S. Woodliff	Jackson.
Minnesota Game and Fish Protective Ass'n	Wm. L. Tucker	Duluth.
Minn. Hunters' and Anglers' Protective Association.	C. S. Brown	Minneapolis.
Missouri State Game and Fish Protective Association.	Frank Cunningham	701 Felix street, St. Joseph.
Missouri Sportsmen's Game and Fish Protective League.	A. J. Dienst	25 South Fourth street, St. Louis.
Montana Fish and Game Protective Ass'n	A. L. Palmer	Helena.
Nebraska Ornithologists' Union	Robert H. Wolcott	Lincoln.
New Jersey State Sportsmen's Association	C. W. Feigonspan	Newark.
New York Association for the Protection of Game.	Robert B. Lawrence	35 Wall street, New York.
New York State Fish, Game, and Forest League.	Ernest G. Gould	Seneca Falls.
North Dakota State Sportsmen's Ass'n	G. E. Carpenter	Fargo.
[Ohio] Cuvier Club of Cincinnati	William J. Lawler	1380 Myrtle avenue, Cincinnati.
Ohio Fish and Game Protective Ass'n	J. C. Porterfield	Columbus.
Ohio Sportsmen's Protective Association	C. T. Bodifield	24 South Water street, Cleveland.
Oklahoma Territorial Sportsmen's Ass'n	J. D. Minton	Enid.
Oregon Fish and Game Association	A. E. Gebhardt	Portland.
[Oregon] John Burroughs Bird Society	Clarence H. Gilbert, pres.	1346 Yamhill st. Portland.
Sportsmen's Association of the Northwest	H. L. Morelans	Portland.
Pennsylvania State Sportsmen's Ass'n	J. M. Runk	Chambersburg.
[Pennsylvania] Delaware Valley Ornithological Club.	Wm. B. Evans	252 South Front street, Philadelphia.
[South Carolina] Western Carolina Game Protection Association.	Charles F. Schwing	Greenville.
South Dakota State Sportsmen's Ass'n	E. E. Aney	Springfield.
Texas Game Protective Association	Turner E. Hubby	Waco.
Texas State Sportsmen's Association	V. C. Dargen	Dallas.
Utah State Fish and Game Protective Association.	George D. Alder	Salt Lake City
Vermont Bird Club	Geo. H. Ross	Rutland.
Vermont Fish and Game League	E. T. Bradley	Swanton.
Eastern Shore Game Protective Association of Virginia.	T. W. Blackstone	Accomac.
W. Virginia State Sportsmen's Ass'n	Ed. O. Bower	Sistersville.
Wisconsin Game Protective Association	August Plambeck	Milwaukee.
Dominion of Canada Trap Shooting and Game Protective Association.	A. W. Throop	Ottawa.
Province of Quebec Association for the Protection of Fish and Game.	Wm. J. Cleghorn	4460 Sherbrooke street, Montreal.
Sportsmen's Fish and Game Protective Association of the Province of Quebec.	E. T. D. Chambers	Quebec.

Audubon societies.

Name of organization.	Secretary.	Post-office.
California	Mrs. George S. Gay	Redlands.
Connecticut	Mrs. W. B. Glover	Fairfield.
Delaware	Mrs. W. S. Hilles	Delamore Place, Wilmington.
District of Columbia	Mrs. John D. Patten	2212 R st., Washington.
Florida	Mrs. I. Vanderpool	Maitland.
Illinois	Miss Mary Drummond	208 Weststreet, Wheaton.
Indiana	William Watson Woollen	Indianapolis.
Iowa	Mrs. Lillian E. Felt	524 Concert st., Keokuk.
[Iowa] Schaller Audubon Society	Miss J. E. Hamand	Schaller.
Kentucky	Ingram Crockett	Henderson.
Louisiana	Miss Anita Pring	1449 Arabella st., New Orleans.
Maine	Mrs. C. B. Tuttle	Fairfield.
Maryland	Miss Anne Weston Whitney.	715 St. Paul st., Baltimore.
Massachusetts	Miss Harriet E. Richards	Society of Natural History, Boston.
Minnesota	Miss Sarah L. Putnam	125 Inglehart st., St. Paul.
[Minnesota] Lake City Audubon Society	Mrs. C. A. Koch	Lake City.
Missouri	August Reese	2516 N. 14th st., St. Louis.
Nebraska	Miss Jay Higgins Lee	554 S. 30th st., Omaha.
New Hampshire	Mrs. F. W. Batchelder	Manchester.
New Jersey	Miss Julia S. Scribner	510 E. Front st., Plainfield.
New York	Miss Emma H. Lockwood	243 W. 75th st., New York.
North Carolina	T. Gilbert Pearson	Greensboro.
Ohio	Mrs. D. Z. McClelland	820 W. 9th st., Cincinnati.
Oklahoma	Mrs. Adelia Holcomb	Enid.
Oregon	Miss Gertrude Metcalfe	634 Williams avenue, Portland.
Pennsylvania	Mrs. Edward Robins	114 S. 21st st., Philadelphia.
Rhode Island	Martha R. Clarke	89 Brown st., Providence.
South Carolina	Miss S. A. Smyth	35 Legare st., Charleston.
Tennessee	Mrs. C. C. Conner	Ripley.
Vermont	Mrs. Fletcher K. Barrows	Brattleboro.
Virginia	Mrs. J. C. Plant	Glencarlyn.
West Virginia	Mrs. Edward Robins	114 S. 21st st., Philadelphia.
Wisconsin	Mrs. Reuben G. Thwaites	260 Langdon st, Madison.
Wyoming	Mrs. N. R. Davis	2116 Ferguson st., Cheyenne.

FARMERS' NATIONAL CONGRESS.

President, Geo. L. Flanders, Albany, N. Y.; first vice-president, Harvie Jordan, Monticello, Ga.; second vice-president, B. Cameron, Stagville, N. C.; secretary, John M. Stahl, No. 4328 Langley avenue, Chicago, Ill.; assistant secretaries, Edward A. Callahan, Albany, N. Y., Geo. M. Whitaker, Boston, Mass., and Joel M. Roberts, Waco, Nebr.; treasurer, J. H. Reynolds, Adrian, Mich.; executive committee, B. F. Clayton, Indianola, Iowa, E. W. Wicke, Ocean Springs, Miss., W. L. Ames, Oregon, Wis., with president and secretary, ex officio.

PATRONS OF HUSBANDRY.

NATIONAL OFFICERS.

Master, Aaron Jones, South Bend, Ind.; overseer, O. Gardner, Rockland, Me.; lecturer, N. J. Bachelder, Concord, N. H.; treasurer, Mrs. E. S. McDowell, Rome, N. Y.; secretary, C. M. Freeman, No. 514 F street, NW., Washington, D. C.; executive committee, E. B. Norris, Sodus, N. Y., C. J. Bell, East Hardwick, Vt., F. A. Derthick, Mantua, Ohio, Aaron Jones, ex officio, South Bend, Ind.

OFFICERS OF

List of masters and other officers for

State.	Master.	Post-office.	Lecturer.	Post-office.
Alabama	H. Hawkins	Hawkinsville	Rev. A. Daugherty	Dothen
California	C. W. Emery	1194 E. Fifteenth street, Oakland.	J. D. Cornell	911 L street, Sacramento.
Colorado	J. A. Newcomb	Golden	J. F. White	Arvada
Connecticut	B. C. Patterson	Torrington	Frank S. Hopson	Stratford
Dakotas, The.[a]				
Delaware	S. H. Derby	Woodside	A. T. Neale	Newark
Idaho.[a]				
Illinois	Oliver Wilson	Magnolia	E. H. Clark	Dunlap
Indiana	Aaron Jones	South Bend	Mrs. L. G. Robertson	South Bend
Indian Ter.[a]				
Iowa	A. B. Judson	Hillsdale	Mrs. Jennie Davis	Murphy
Kansas, including Oklahoma	E. W. Westgate	Manhattan	A. P. Reardon	McLouth
Kentucky	F. P. Wolcott	Covington	J. B. Walker	Hopkinsville
Maine	Obadiah Gardner	Rockland	W. J. Thompson	South China
Maryland	Joseph B. Ager	Hyattsville	Prof. J. S. Robinson	College Park
Massachusetts	Geo. S. Ladd	Sturbridge	Chas. H. Rice	Leominster
Michigan	Geo. B. Horton	Fruitridge	Mrs. F. D. Saunders	Rockford
Minnesota	Mrs. S. G. Baird	Edina Mills	Geo. C. Hill	Sherburne
Mississippi	S. L. Wilson	Okolona	H. F. Simrall	Glass
Missouri	C. O. Raine	Monticello	T. B. Dunham	New Cambria
Nebraska	J. M. Williams	Culbertson	A. M. Bovee	Vacoma
New Hampshire	N. J. Bachelder	Concord	Henry H. Metcalf	Concord
New Jersey	Geo. W. F. Gaunt	Mullica Hill	Geo. L. Gillingham	Moorestown
New York	Elliot B. Norris	Sodus	Mrs. B. B. Lord	Sinclairville
North Dakota.[a]				
Ohio	F. A. Derthick	Mantua	John Begg	Columbus Grove.
Oklahoma.[a]				
Oregon, including Idaho	B. G. Leedy	Tigardville	Austin T. Buxton	Forestgrove
Pennsylvania	W. F. Hill	Vandegrift	A. M. Cornell	Altus
Rhode Island	A. A. Smith	Woonsocket	T. S. Snow	Wakefield
South Carolina	W. K. Thompson	Libertyhill	I. W. English	Bishopville
South Dakota.[a]				
Tennessee	W. L. Richardson	Brownsville	J. M. McCorkle	Whitehaven
Texas	R. D. McGee	Stockdale	John B. Long	Rusk
Vermont	C. J. Bell	East Hardwick	R. B. Galusha	South Royalton.
Washington	J. O. Wing	Mount Pleasant	J. H. T. Smith	Pullman
West Virginia	T. C. Atkeson	Morgantown	S. W. Moore	Elwell
Wisconsin	A. C. Powers	Beloit	S. C. Carr	Milton Junction.

[a] The Dakotas are annexed to Minnesota; also Idaho is included with Oregon, Oklahoma with Kansas, and Indian Territory with Texas.

STATE GRANGES.

1902, so far as reported on April 1.

Treasurer.	Post-office.	Secretary.	Post-office.	Date of meeting.
W. J. Roundtree	Valegrande	F. Shackelford, jr.	Colquitt	Wednesday after second Monday in July.
Daniel Flint	620 N street, Sacramento.	Mrs. L. S. Brasch	1251 Eleventh avenue, San Francisco.	First Tuesday in October.
W. W. Groves	Globeville	Will. T. Wilson	Niwot	Second Tuesday in January.
Norman S. Platt	395 Whalley avenue, New Haven.	H. E. Loomis	Glastonbury	Do.
Thomas H. Riggin	Laurel	W. W. Seeders	Farmington	Second Tuesday in December.
D. Q. Trotter	Piasa	Thomas Keady	Dunlap	Do.
J. W. Holmes	Cortland	Taylor B. Frazier	Frankfort	Do.
M. E. Blair	Manchester	F. M. Laird	Tabor	Second Tuesday in October.
William Henry	Olathe	George Black	Olathe	Second Tuesday in December.
J. Comer	Union	Miss Nannie D. Bristow.	Union	Second Tuesday in October.
M. B. Hunt	Center Belmont.	E. H. Libby.	R. R. 4, Auburn	Third Tuesday in December.
Morris C. Reeder	Rising Sun.	Dr. H. B. McDowell.	College Park	Second Tuesday in December.
F. A. Harrington	Worcester	Wm. N. Howard	South Easton	Do.
E. A. Strong	Vicksburg	Miss Jennie Buell	Ann Arbor	Do.
C. Varley	Sherburne	Mrs. A. J. Adams	Box 447, Minneapolis.	Second Tuesday after December 4.
Mrs. Joe Bailey	Conehatta	T. J. Aby	Fayette	Second Tuesday in December.
W. P. Haines	Gilman City	E. H. Long	Monticello	Second Tuesday in October.
B. S. Gitchell	Butler	J. R. Cantlin	Webster	Second Tuesday in December.
Joseph D. Roberts	Dover	E. C. Hutchinson	Milford	Third Tuesday in December.
C. Collins	Moorestown	M. D. Dickinson	Woodstown	First Thursday in December.
P. A. Welling	Hannibal	W. N. Giles	Skaneateles	First Tuesday in February.
W. W. Miller	Columbus	C. M. Freeman	Tippecanoe City (R. D. 64).	Second Tuesday in December.
J. Hershberg	Independence	Mrs. Mary S. Howard.	Mulino	Fourth Tuesday in May.
S. E. Niven	Landenburg	J. T. Ailman	Thompsontown.	Second Tuesday in December.
Benjamin Martin	East Providence.	Alton F. Coggeshall.	South Portsmouth.	Do.
H. Boykin	Ionia	W. A. James	Bishopville	Second Wednesday in December.
D. A. Stewart	Brownsville	Mrs. E. L. Allen	Brownsville	Third Tuesday in August.
J. L. Howell	Dublin	J. J. Ray	Dublin	Second Tuesday in August.
F. B. Pier	Rawsonville	A. A. Priest	Randolph	Second Wednesday in December.
William Smiley	Vancouver	F. C. Briggs	Lacenter	First Tuesday in June.
Alex. Clohan	Martinsburg	M. V. Brown	Buffalo	Second Wednesday in January.
George Harwood	Chippewa Falls	Geo. R. Schaefer	Appleton (R. D. 2).	Second Tuesday in December.

FOREIGN OFFICIALS CHARGED WITH AGRICULTURAL INTERESTS.

Argentine Republic.—Su Excelencia el Ministro de Agricultura, Ministerio de Agricultura, Casa de Gobierno, Buenos Aires.

Austria-Hungary.—Seine Excellenz, K. K. Minister für Ackerbau, Vienna. Seine Excellenz, Kgl. Ungarischer Minister für Ackerbau, Budapest.

Belgium.—Son Excellence le Ministre de l'Agriculture, Département de l'Agriculture, Brussels.

Bolivia.—Su Excelencia el Ministro de Agricultura, La Paz.

Brazil.—Ministro de Industria, Viaçao e Obras Públicas Rio de Janeiro.

Chile.—Su Excelencia el Ministro de Industria y Obras Públicas, Santiago.

Colombia.—No minister.

Costa Rica.—Su Excelencia el Secretario de Fomento, San José.

Cuba.—Su Excelencia el Secretario de Agricultura, Industria y Comercio, Habana.

Denmark.—Son Excellence le Ministre de l'Agriculture, Nos. 6-8-10 Slatsholmsgade, Copenhagen.

Ecuador.—Su Excelencia el Ministro de Instrucción Pública y Fomento, Quito.

France.—Son Excellence le Ministre de l'Agriculture, 78 Rue de Varennes, Paris.

Germany.—No imperial minister of agriculture.

Prussia.—Seine Excellenz der Königliche Staatsminister für Landwirtschaft, Domänen und Forsten, Berlin.

Other States of the Confederation.—Agricultural interests are looked after either by the minister of the interior or minister of finance.

Great Britain.—President of the Board of Agriculture, 4 Whitehall Place, London S. W.

Guatemala.—Su Excelencia el Secretario de Estado en el Despacho de Fomento, Guatemala City.

Haiti.—Son Excellence le Secrétaire d'Etat de l'Agriculture, Port-au-Prince.

Italy.—Sua Eccelenza il Ministro di Agricoltura, Industria e Comercio, Rome.

Japan.—Minister of Agriculture and Commerce, Department of Agriculture and Commerce, Tokyo.

Korea.—Mr. Min Chong Mook, Dông Hyun; Nam Soh, Seoul, Korea.

Mexico.—Su Excelencia el Secretario de Fomento, Secretaría de Fomento, Mexico City.

Netherlands.—Son Excellence le Ministre du Waterstaat, Commerce et Industrie, The Hague, Holland.

Nicaragua.—Su Excelencia el Ministro de Fomento y Obras Públicas, Managua, Nicaragua.

Peru.—Su Excelencia el Ministro de Fomento y Obras Públicas, Palacio de Gobierno, Lima.

Portugal.—Ministro e Secretario d'Estado dos Negocios das Obras Públicas, Commercio e Industria.

Russia.—Son Excellence le Secretaire d'Etat, Ministre de l'Agriculture et des Domaines, St. Petersburg.

Salvador.—Dirección General de Agricultura, San Salvador, Salvador.

Siam.—His Excellency Phya Deves, Minister of Agriculture, Bangkok.

Spain.—Su Excelencia el Ministro de Agricultura, Madrid.

Sweden and Norway.—Herr Statsradet m. m. Kgl. Jordbruks-Departementet, Stockholm, Sweden; Herr Statsraad m. m., Det. Kgl. Landbrugs-Departement, Christiania, Norway.

Switzerland.—Chief of the Department of Commerce and Agriculture, Berne.

Turkey.—Son Excellence, Zuhdi Pacha, Minister des Travaux Publiques et du Commerce.

Uruguay.—Su Excelencia el Ministro de Fomento, Montevideo.

Venezuela.—No minister of agriculture.

AGRICULTURAL OFFICIALS IN AUSTRALIA AND SOUTH AFRICA.

Ministers and Secretaries for Agriculture.

New South Wales.—The Hon. John Kidd, Secretary for Mines and Agriculture, Sydney.

Queensland.—The Hon. D. H. Dalrymple, Secretary for Agriculture, Brisbane.

South Australia.—The Hon. T. H. Brooker, Minister of Education and Agriculture, Adelaide.

Tasmania.—The Hon. G. Collins, Chief Secretary and Minister of Defense and Agriculture, Hobart.

Victoria.—The Hon. J. Morrissey, Minister of Agriculture, Melbourne.

Western Australia.—L. Lindley Cowen, esq., Secretary Department of Agriculture, Perth.

Cape Colony.—The Hon. Sir P. H. Faure, K. C. M. G., Secretary for Agriculture, Cape Town.

Natal.—The Hon. Henry Daniel Winter, M. L. A., Minister of Agriculture, Durban.

Orange River Colony.—T. Smith, esq., Agricultural Adviser, Bloemfontein.

Transvaal.—No official.

CANADIAN OFFICIALS IN CHARGE OF AGRICULTURE.

Ministers of Agriculture.

Dominion of Canada	Sydney A. Fisher	Ottawa.
Ontario	John Dryden	Toronto.
Quebec	F. G. M. Déchêne	Quebec.
British Columbia	J. D. Prentice	Victoria.
Manitoba	R. P. Roblin (*also* Premier)	Winnipeg.

Commissioners of Agriculture.

New Brunswick	L. P. Farris	Fredericton.
N. W. Territories	G. H. V. Bulyea	Regina.
Prince Edward Island	Benjamin Rogers	Charlottetown.

Secretary of Agriculture.

Nova Scotia	B. W. Chipman	Halifax.

Minister of Agriculture and Mines.

Newfoundland	Eli Dawe	St. Johns.

REVIEW OF WEATHER AND CROP CONDITIONS, SEASON OF 1902.

By JAMES BERRY, *Chief Climate and Crop Division, Weather Bureau.*

The accompanying tables and illustrations (see figures 56, 57, 58, 59, and 60, pages 694, 695, 696, 697, and 698) show how the temperature and rainfall over the United States during the crop season of 1902 from week to week compare with normal conditions of corresponding periods of former years. The diagrams exhibit the departures from normal, by districts, and the maps show respectively the departures from normal temperature, the total precipitation, and departures from normal precipitation during the crop season.

JANUARY.

January averaged slightly colder than usual in the central and east Gulf States, generally throughout the Atlantic coast districts, in northern California and on the immediate coast of Washington, and nearly normal in the lower Lake region, Ohio Valley, central and western Texas, and over the western portions of the Plateau regions, while from the upper Lake region westward to Idaho the month was exceptionally mild.

The precipitation was generally light, only a few comparatively small areas receiving more than the January average. Over a narrow strip of country extending from western Arkansas northeastward to northern Virginia the monthly precipitation was considerably in excess of the average, the total over this area exceeding 6 inches. A small area embracing portions of northeastern Kansas, southeastern Nebraska, southwestern Iowa, and northwestern Missouri also

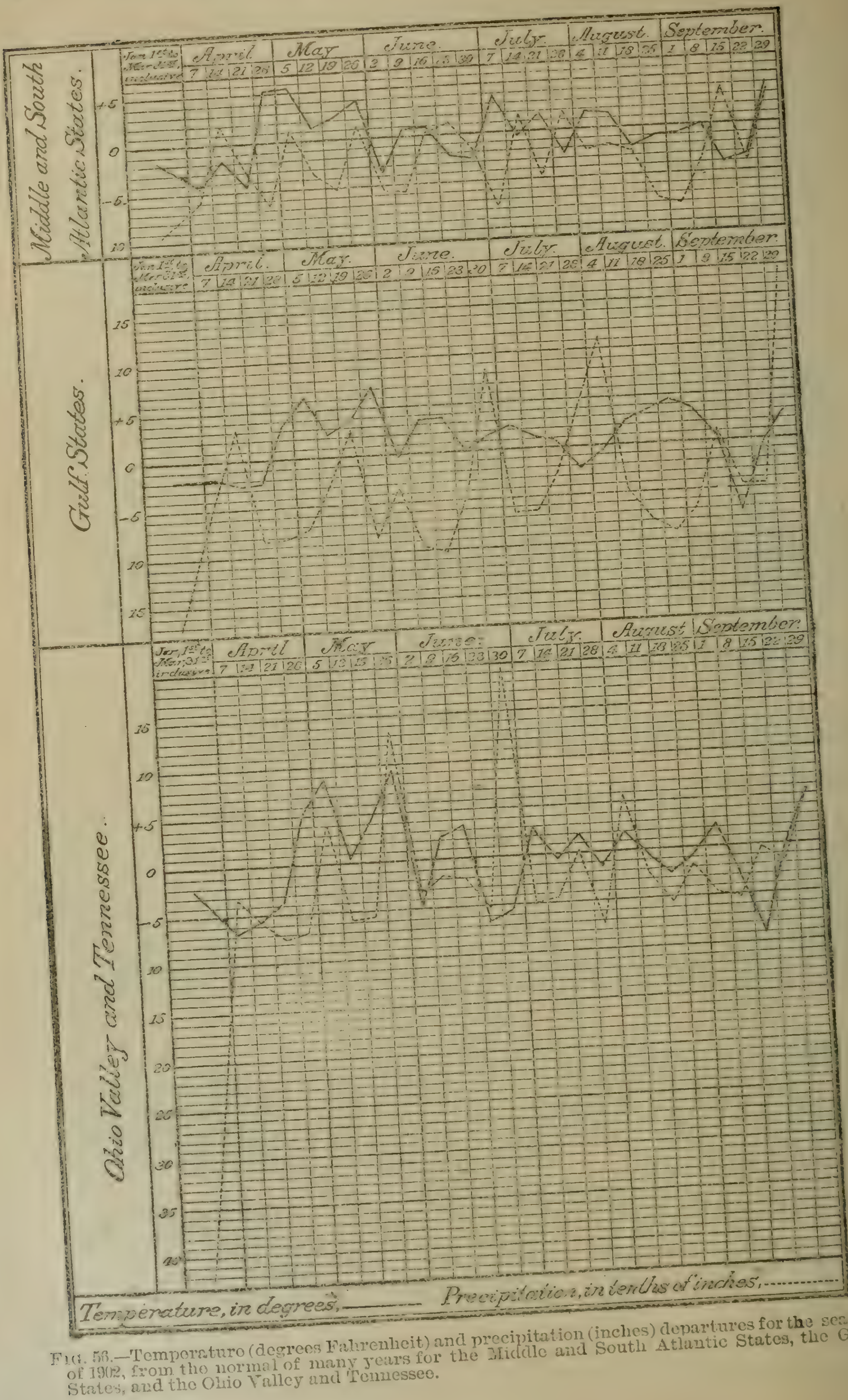

FIG. 58.—Temperature (degrees Fahrenheit) and precipitation (inches) departures for the season of 1902, from the normal of many years for the Middle and South Atlantic States, the Gulf States, and the Ohio Valley and Tennessee.

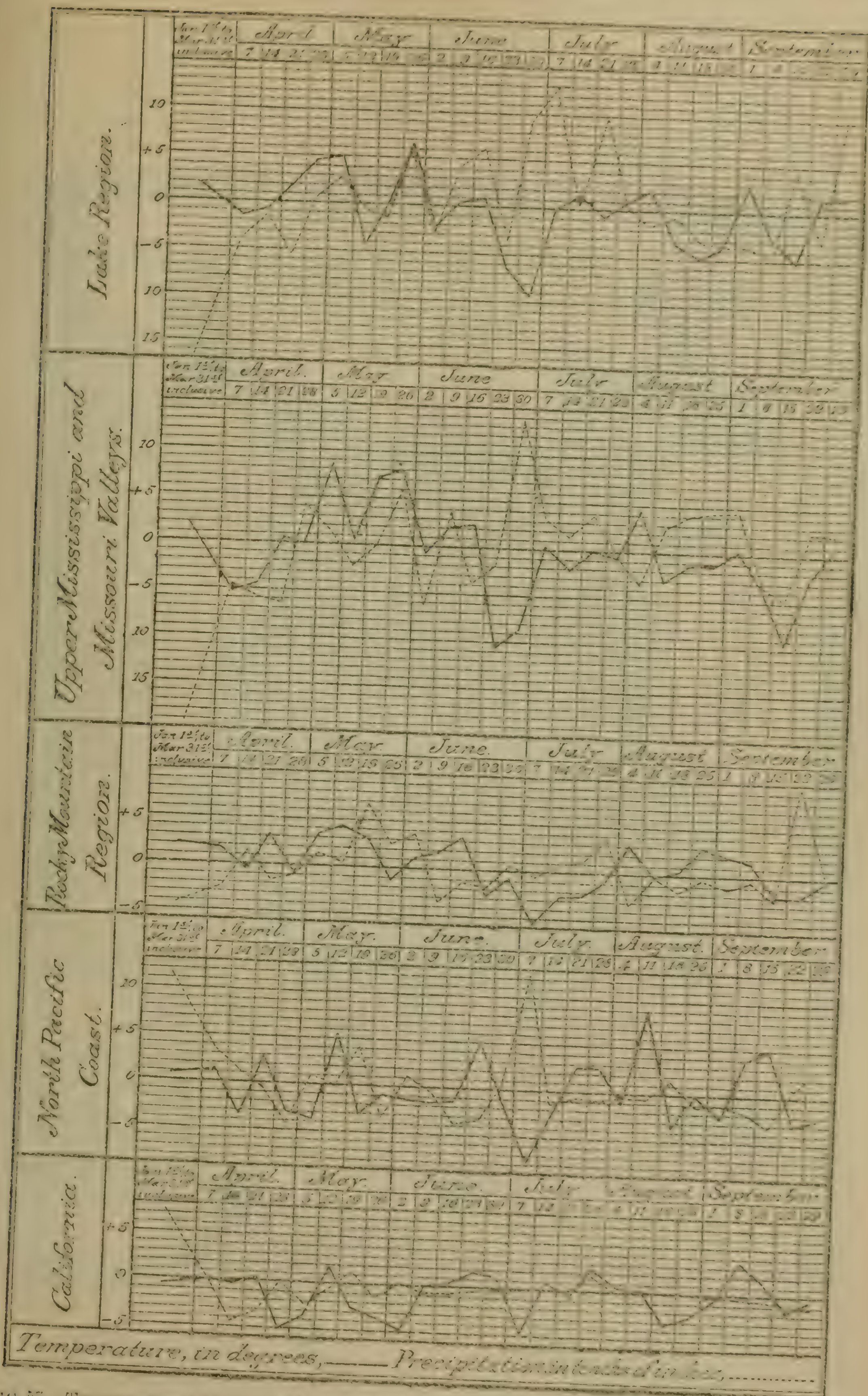

FIG. 57. Temperature (degrees Fahrenheit) and precipitation (inches) departures for the season of 1902 from the normal of many years for the Lake Region, the Upper Mississippi and Missouri valleys, the Rocky Mountain region, the North Pacific coast, and California.

FIG. 53.—Average daily departures from normal temperature for the crop season of 1902, from April 7 to September 29.

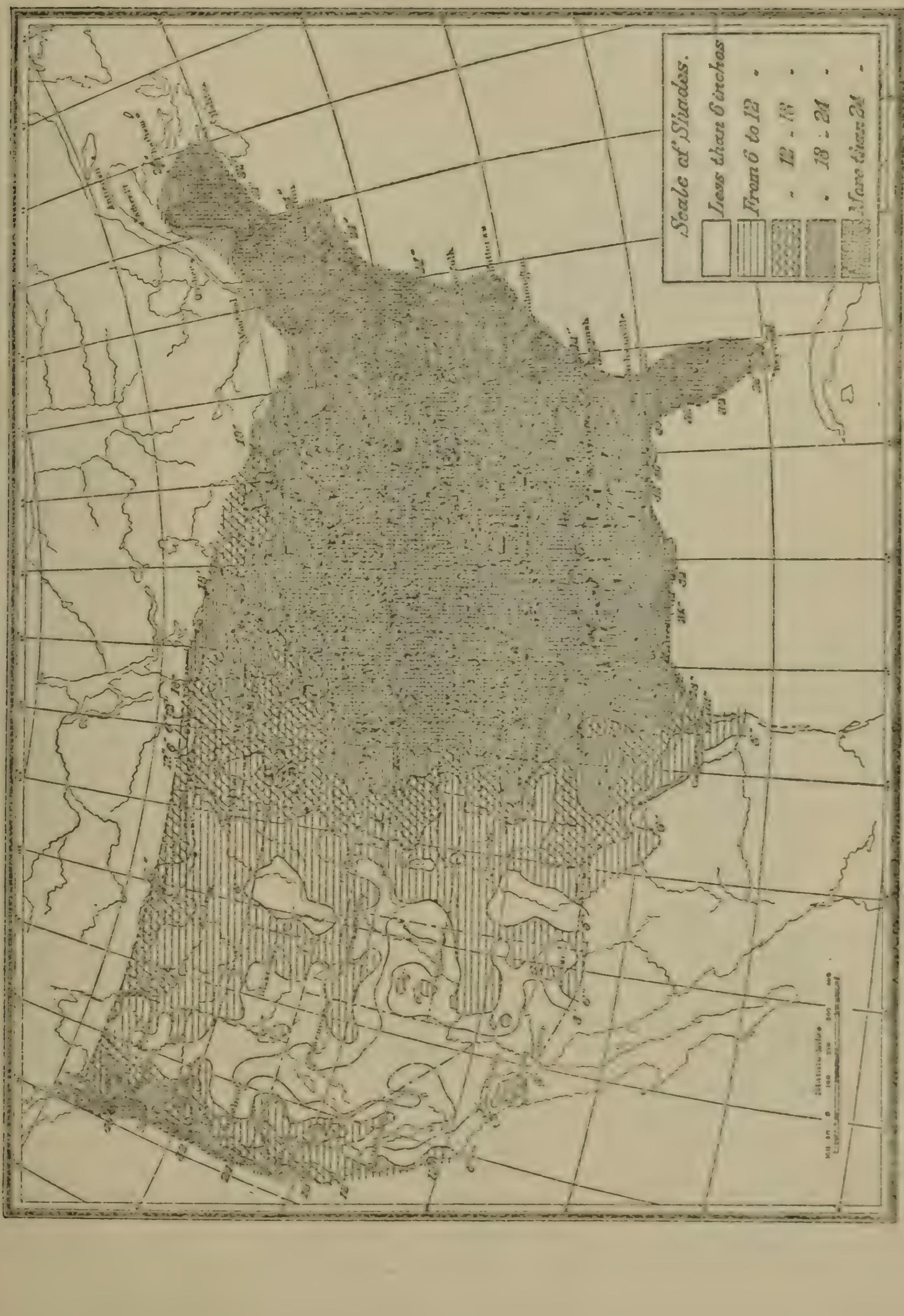

FIG. 59.—Total precipitation for the crop season of 1902, from April 7 to September 29.

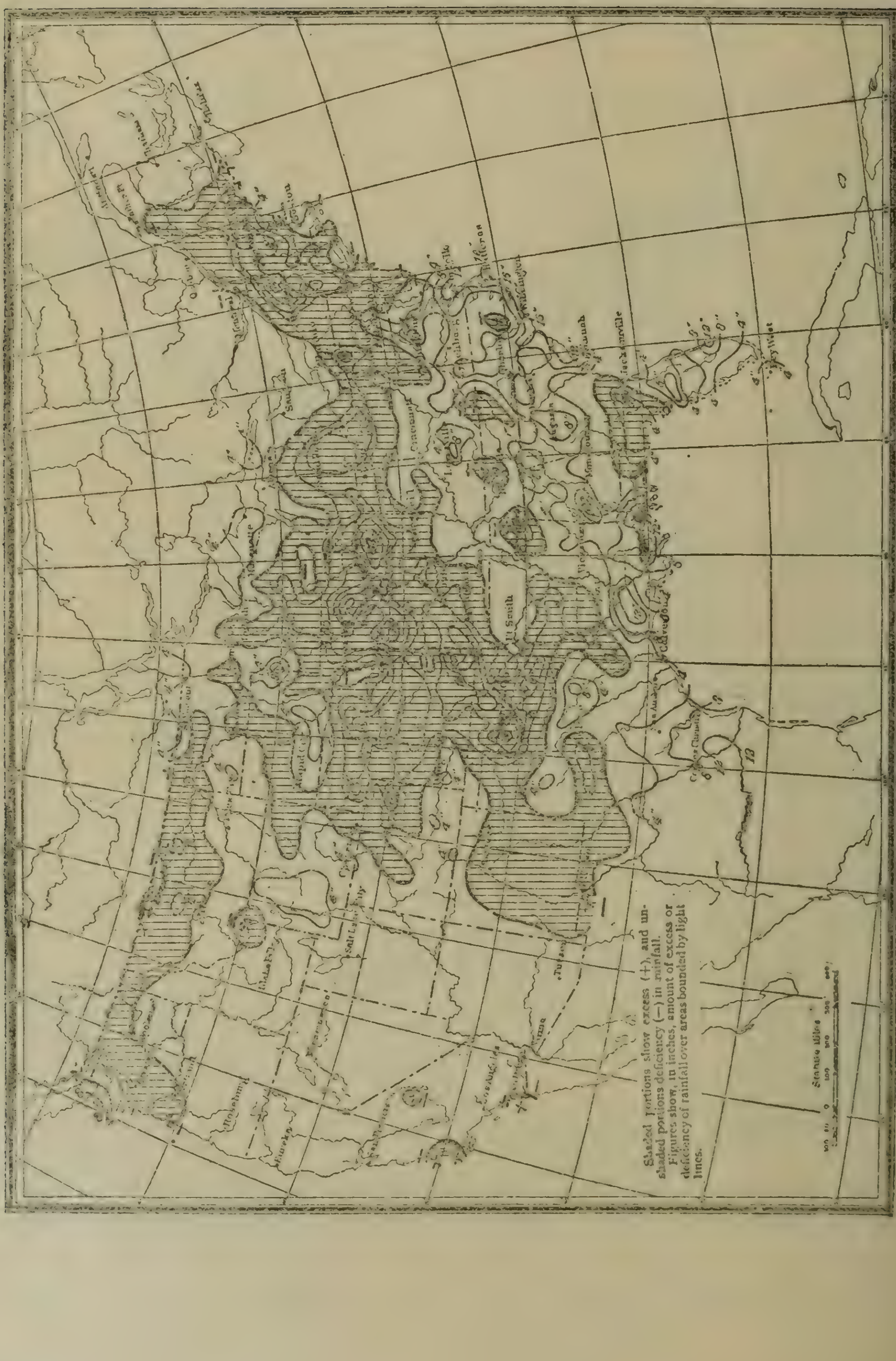

FIG. [illegible].—Departures from normal precipitation for the crop season of 1902, from April 7 to September 29.

received slightly more than the January average. Throughout the Gulf and South Atlantic States, New England, the Lake region, upper Mississippi Valley, the Rocky Mountain and Pacific Coast districts, the precipitation was much below the average.

SNOW AND WINTER WHEAT.

At the close of the month snow covered the entire northern part of the country from New England and the Middle Atlantic States to the North Pacific coast, the southern limit extending to the Ohio and lower Missouri valleys, with traces as far south as Tennessee and northern Texas. The principal wheat States of the central valleys were generally well covered to depths ranging from 2 to 7 inches, and depths ranging from 1 to more than 2 feet were reported from the interior of northern New England and from stations along the southern shore of Lake Superior.

The reports respecting winter wheat were generally unfavorable except in Kansas and Nebraska, where the outlook was encouraging, although in the first named State the crop was too closely grazed in some sections. Alternate thawing and freezing, with little or no snow protection during the greater part of the month, in the Mississippi and Ohio valleys and Middle Atlantic States, proved very unfavorable to winter wheat. A considerable area in Kentucky and Tennessee was plowed up and devoted to other crops. The general outlook for winter wheat on the Pacific coast was encouraging.

FEBRUARY.

February averaged decidedly cold in the central valleys, Southern States, over the southern part of the Lake region and in the Atlantic coast districts south of New England, while over the northern portion of the upper lake region, in Minnesota, the Dakotas, throughout the Rocky Mountain regions and on the Pacific coast, except in extreme southern California, the month averaged milder than usual.

In the Atlantic coast and east Gulf districts, with the exception of Northern New England and small areas along the immediate South Atlantic coast, the precipitation was very heavy. From the east Gulf coast northeastward to southern New England the precipitation generally ranged from 4 to 6 inches, more than 8 inches occurring over southern Alabama and extreme west Florida, where destructive freshets occurred in many rivers. Throughout the central valleys, Lake region, central and west Gulf States, and over the eastern Rocky Mountain slope the month was drier than usual. On the Pacific coast the precipitation was in excess of the average, being unusually heavy in all districts except extreme southern California. At the close of the month but little unmelted snow remained on the ground except in the extreme northern portions of the Lake region and New England.

PROGRESS OF FARM WORK—CONDITION OF WHEAT.

In the lower Missouri and upper Mississippi valleys to the northward of the Ohio River and in the Middle Atlantic States the month, although cold, was generally favorable for the prosecution of such farm work as is usually performed in winter. In the Southern States the conditions were not favorable for farm work. Moderate rainfall partially relieved drought in eastern Texas, but elsewhere in that State drought conditions continued. On the Pacific coast the temperature was favorable and the rainfall abundant.

The northern portion of the winter-wheat belt was generally well protected by snow during the month, and an improvement in the condition of winter wheat was indicated over the northern portions of Ohio, Indiana, Illinois, and Missouri, the outlook being less favorable over the southern portions of these States and in Kentucky, Tennessee, and Arkansas. The severe sleet storm near the close of January left a large portion of the Ohio Valley covered with ice, which remained on the ground for a considerable part of February. In Nebraska and Kansas wheat as a whole was in promising condition. In California the condition of the crop had materially improved, except in a few sections where the rain came too late to save the early sown. In western Oregon the crop was in excellent condition, and it was generally promising in eastern Oregon, where, however, some had been winterkilled. In Washington the severe cold of the latter part of January caused serious injury in localities, but where not injured by cold it made good growth.

March.

The weather conditions of March were generally favorable for farming operations in the States of the Missouri, upper Mississippi, and Ohio valleys, and on the Atlantic coast north of North Carolina. The month was also favorable in Florida, Texas, and Oklahoma, but over the greater part of the central and east Gulf States it was unfavorable, largely on account of excessive rains. Throughout the central and east Gulf States farm work was from two to three weeks late, and in many sections much land was badly washed. On the Pacific coast the month was cool and the season generally backward.

WHEAT, OATS, AND CORN.

There was a very general and in some sections a marked improvement in the condition of winter wheat in the States of the central valleys, although much of the late sown was in poor condition and some was plowed up for other crops. The cool weather on the Pacific coast retarded the growth of winter wheat. In California some damage was done by heavy rains, but on the whole wheat was in promising condition. In Oregon the condition of wheat was less promising than usual, especially in the eastern part of the State. An improvement was indicated in Washington, although considerable reseeding was necessary. By the close of the month some spring wheat was sown over the southern portion of the spring-wheat region. Oat seeding was well advanced in the States of the Missouri Valley and was progressing in the Ohio Valley and Middle Atlantic States. Fall-sown oats in the Southern States were winterkilled to a great extent. Corn planting was begun as far northward as Kansas and Missouri, and preparations for planting were in progress farther north. In Texas the bulk of the corn crop was planted and some had been planted in the central and east Gulf and South Atlantic States. In Texas and Florida cotton planting was well advanced, but in Georgia, Alabama, Mississippi, and Louisiana none had been planted and very little ground had been prepared owing to heavy rains.

The Crop Season, April–September, Summary by Weeks.

By weeks, ending with Monday, from April 14 to September 29, the crop conditions may be summarized as follows:

April 14.—This week averaged cold in the central valleys and over the interior portions of the Atlantic coast and east Gulf districts, although milder temperatures prevailed during the latter part in the last-named districts. Rain was much needed in the Ohio, central Mississippi, and lower Missouri valleys, over the western portion of the Lake region, in southern Florida, and the Rio Grande Valley, including New Mexico and Colorado. Frosts occurred as far south as the northern portions of the east Gulf States and the interior of the Carolinas, but caused no serious damage. Corn planting was nearing completion in the west Gulf States and had made favorable progress in the South Atlantic and east Gulf districts and Tennessee. This work was general in Kansas and Missouri, and preparations in Iowa were unusually advanced. Eastward of the Mississippi no corn had been planted northward of Tennessee, excepting a little in southern Virginia. In Texas and Louisiana much of the crop was up to fine stands and cultivation had begun. While the growth of winter wheat was slow, a very general improvement was reported from the principal wheat States, although the crop suffered slightly in central and northern Illinois and was in need of rain in northern Missouri. Though somewhat improved in Kentucky, Tennessee, and Virginia, the condition of wheat in these States continued much below the average. On the Pacific coast winter wheat made rapid growth in California, but in Oregon and Washington the condition of the crop was less promising, especially in the last-named State, where a large area had to be resown. Spring wheat seeding was well advanced in the southern portion of the spring-wheat region, and a little was sown in southern North Dakota. Oat seeding was well advanced in the States of the Missouri Valley, but made less favorable progress in the Ohio Valley. The early sown promised well in Oklahoma, Kansas, and the southern portions of Nebraska and Missouri, but germination was slow in the Ohio Valley. Cotton planting was well advanced westward of the Mississippi and the early planted was coming up to satisfactory stands in Texas. Eastward of the Mississippi planting, although late, was well under way over the southern portions of Alabama, Georgia, and South Carolina.

April 21.—This week was warmer than the average in the Pacific coast and

Rocky Mountain regions, in the Missouri Valley, and the northern districts to the eastward, but was too cool in the Middle Atlantic and Southern States and decidedly dry over the greater part of the central valleys and Middle Atlantic States, while excess of moisture hindered farm work in portions of the central Gulf States. The latter part of the week was marked by abnormally high temperatures in Kansas and Nebraska, intensifying the drought conditions in those States. The general weather conditions, although not conducive to rapid advance of vegetation, were very favorable for farming operations in nearly all parts of the country.

WHEAT, WHEAT SEEDING, AND CORN PLANTING.

The progress of corn planting was rather slow, except in Missouri and the Southern States, this work being about finished in the central and the west Gulf districts.

Winter wheat continued to make slow growth, and on the whole was in less promising condition in the principal winter-wheat States of the central valleys than at the close of the previous week. Moisture and milder temperatures were generally needed for this crop throughout these districts and also in the Middle Atlantic States. The outlook in California continued promising and the crop experienced improvement on the north Pacific coast. The germination of early sown spring wheat over the southern portion of the spring-wheat region was slow, and seeding was retarded by freezing in North Dakota. The Red River Valley lands in Minnesota dried nicely and seeding began on the 15th. Some reseeding was necessary in Minnesota as a result of the dust storm of April 10 and 11. Seeding progressed favorably on the north Pacific coast.

Very good progress was made with cotton planting, except in portions of Tennessee, the Carolinas, and Florida, and planting was nearing completion over the southern portion of the cotton belt. Over most of Texas cotton was up to satisfactory stands, and plowing and chopping were well under way.

April 28.—Much-needed and generally abundant rains fell over a large part of the Missouri, upper Mississippi, and lower Ohio valleys, but droughty conditions continued in the Upper Ohio Valley, Middle Atlantic States, and over the southeastern Rocky Mountain slope. Rain was now very generally needed over the greater part of the Southern States, more particularly the eastern and western districts, good showers having fallen over a portion of the central Gulf States. A heavy snowstorm interfered with farm work in Montana, the Dakotas, and Minnesota during the early part of the week, and the high and drying winds of the latter part in the central valleys and Middle Atlantic States were detrimental. The temperature conditions in the Southern States and in the northern districts east of the Mississippi were very favorable, but the week was too cool for favorable growth in the Rocky Mountain and north Pacific coast States.

Considerable corn was planted in Illinois, some in southern portions of Ohio and Iowa, and planting was well advanced in Missouri, Kansas, Kentucky, and Virginia. In the Southern States corn made good growth and was in various stages of cultivation, some being ready to be laid by in Texas and Louisiana.

Winter wheat experienced improvement in Illinois and portions of Missouri, and was slightly improved in Ohio and the Middle Atlantic States. The crop suffered no injury as a result of marked temperature extremes of this and the preceding week in Kansas and Nebraska, where, however, in some sections it needed moisture. Winter wheat also needed rain in the central and upper Ohio valleys, no improvement having been reported from Indiana, where a considerable acreage in the central part of the State was plowed up. On the Pacific coast winter wheat made favorable progress, a heavy crop having been promised in California north of Tehachapi.

The cotton States experienced a very favorable week, and cotton planting made rapid progress in all sections, and was practically finished in Texas. Much of the early planted throughout the cotton belt was up to good stands and cultivation was well advanced.

May 5.—Nearly the entire country east of the Rocky Mountains experienced a week of highly favorable temperature conditions, and the central valleys, Lake region, Middle Atlantic States, and portions of Texas and Oklahoma received ample, but in places unevenly distributed, rainfall. Excessive rain retarded farm work in northern New England and the northern portion of the spring-wheat region, while the central and eastern Gulf States and portions of the South Atlantic coast needed rain. The middle and southern Rocky Mountain regions continued to suffer from severe drought with disastrous effects to crops and live stock. Over the western portion of the Plateau region and on the Pacific coast

the week was decidedly cool with heavy frosts in the Plateau districts. Warm and dry weather was much needed in Washington and Oregon.

Except in portions of Iowa and Missouri, where corn planting was interfered with by heavy rains, this work made very favorable progress in the States of the central valleys, and the early planted generally germinated well. Some planting was done in South Dakota. Preparations for planting in the extreme northern portion of the corn belt were well advanced, the soil being in generally excellent condition. In the Southern States corn made favorable progress, though needing rain in portions of the east Gulf districts. There was a very general improvement in the condition of winter wheat in the central valleys, Lake region, and Middle Atlantic States. The crop, however, suffered in portions of Nebraska, Kansas, and Texas, and in the last-named State failed so rapidly in sections that some was plowed up for other crops. Favorable reports continued from California, except in the southern part of the State. In Oregon and Washington the crop, though late, was in promising condition, especially in Oregon. Spring-wheat seeding was delayed in North Dakota and northern Minnesota, but made favorable progress in the southern portion of the spring-wheat region, where the early sown germinated well.

SEVERE DROUGHT IN MIDDLE AND SOUTHERN ROCKY MOUNTAIN STATES AND EXCESSIVE RAINS IN GREAT VALLEYS AND LAKE REGION.

May 12.—From the upper Mississippi Valley eastward to the New England and middle Atlantic coasts this week was decidedly cold and unfavorable to growth, with light to heavy frosts, causing much damage to fruit in the northern portion of the Middle Atlantic States and in New England. The temperature conditions in the Southern States, Missouri Valley, and throughout the Rocky Mountain and Pacific coast districts were favorable, highly so on the north Pacific coast. Drought continued in Florida and over portions of the east Gulf and South Atlantic States, and rain was generally needed in the Ohio Valley and Middle Atlantic States. Rains afforded relief locally in the middle and southern Rocky Mountain districts, but were generally insufficient, while the greater part of the upper Lake region and portions of the upper Mississippi, upper Missouri, and Red River of the North valleys suffered from excessive moisture.

Owing to excessive rains little or no corn had yet been planted in Minnesota and Wisconsin, and planting was delayed in South Dakota and northern Iowa, but generally throughout the central valleys and Middle Atlantic States this work had made rapid progress. Good stands were generally reported in the Mississippi and Missouri valleys, but cutworms impaired stands in the Ohio Valley and Tennessee. In Kansas, Oklahoma, and Texas the crop made rapid growth and much had been laid by in Texas.

Winter wheat generally made satisfactory progress, the least favorable reports being from the Ohio Valley and Middle Atlantic States. The crop advanced rapidly in the lower Missouri Valley, in the southern portion of which it was heading. The north Pacific coast region and central and northern California experienced a week highly favorable to the wheat crop. Early sown wheat germinated well and made vigorous growth, especially in the southern portion of the spring-wheat region. Owing to continued rains, seeding was much delayed.

Very encouraging reports respecting cotton were received from all parts of the cotton belt, with the exception of Florida and portions of the central districts, where rain was needed to germinate the late planted. The frosts of the 10th were damaging to fruit in the upper Ohio Valley, over the northern portion of the Middle Atlantic States, and in New England, being most destructive in New York.

May 19.—The drought conditions prevailing at the close of the previous week in the South Atlantic and east Gulf States were largely relieved, except in southern Florida, but the continued dry weather in the Ohio Valley and Middle Atlantic States, with low temperatures during the first half of the week over the northern portion of the Middle Atlantic States and in New England, proved unfavorable, while the Dakotas, Minnesota, and portions of Iowa suffered from excessive moisture. Frosts, more or less destructive, were quite general in the Lake region, upper Ohio Valley, and in the northern portions of the Middle Atlantic States and New England. The temperature conditions in the lower Ohio, Mississippi, and Missouri valleys and throughout the eastern Rocky Mountain slope were highly favorable, but on the north Pacific coast and in the middle Plateau districts the week was much too cool.

May 26.—This week was one of highly favorable temperature conditions in all districts east of the Rocky Mountains, with abundant rainfall over the greater

portion of the central valleys, Lake region, and Middle Atlantic States. Drought conditions in the Ohio Valley were effectually relieved, except in southern Illinois, and partially broken over the greater part of the Middle and South Atlantic States. Rain was much needed in Tennessee, over the northern portions of Mississippi and Alabama, and in central and southern Florida. Excessively heavy rains retarded work and caused some damage by washing and overflows in the Lake region and in the States of the Ohio and Missouri valleys. On the Pacific coast the first part of the week was too cold in Washington and Oregon, but more favorable conditions prevailed during the latter part; in California, with the exception of drying winds, the week, though cooler than usual, was generally favorable. Heavy frosts occurred on the 19th and 20th in the middle and southern Rocky Mountain districts, causing considerable damage.

Heavy rains interrupted corn planting over extensive areas in the Missouri, upper Mississippi, and Ohio valleys and Lake region, in portions of which districts much replanting was rendered necessary as a result of overflows and washed lands. The early-planted corn made good growth throughout the central valleys, but suffered for cultivation in the lower Missouri Valley. In the Southern States the crop made good progress, and much of the early planted was being laid by.

An improvement in the condition of winter wheat was reported from Nebraska, Kansas, portions of Illinois, and in Indiana, Michigan, and Wisconsin, and the crop continued in fine condition in Missouri, except in a few southeastern counties. The reports from Tennessee, Kentucky, Ohio, the Middle, South Atlantic and east Gulf States indicated that the crop was heading low, with prospects of very light yields. On the Pacific coast the outlook continued favorable, except in southern California; the crop was, however, reported as unusually weedy in Oregon. Early spring wheat made vigorous growth; the later sown was coming up well, with seeding practically finished.

In the Middle, South Atlantic, and east Gulf States, and portions of the Ohio Valley, the outlook for oats was not promising, but more favorable conditions were reported from the Missouri and upper Mississippi valleys and the Lake region. Harvesting was in progress in the central and west Gulf States.

But few adverse reports respecting cotton were received. In portions of Texas, Oklahoma, and Alabama the crop was getting grassy, and boll weevil were increasing and lice appearing in southern Texas. Generally throughout the cotton belt, however, fields were clean and the crop made good growth, and squares were forming throughout the southern portion.

Recent rains in the Ohio Valley, Tennessee, and the Middle Atlantic States put the soil in favorable condition for transplanting tobacco, which work was well advanced in these districts. In the Carolinas stands were irregular and insects destructive. Plants were generally plentiful, except in central and eastern Kentucky, but were overgrown in portions of Virginia and Tennessee. Orchards sustained some damage by local storms in the Ohio Valley, and on the whole the general fruit outlook was less encouraging than earlier in the season.

ABNORMALLY COOL, WITH FROSTS IN CENTRAL VALLEYS CHECKING GROWTH—COMPLETION OF CORN PLANTING.

June 2.—This week was abnormally cool in the lower Missouri, central Mississippi, and Ohio valleys and on the Atlantic coast northward of the Carolinas. Frosts, more or less destructive, occurred from the 27th to the 29th of May in the Lake region, Ohio Valley, Tennessee, western North Carolina, over the interior portions of the Middle Atlantic States, and generally throughout New England. In nearly all districts east of the Rocky Mountains crop growth was checked by low temperatures, and rains interfered with farm work in Oklahoma, Kansas, Missouri, and Arkansas. On the Pacific coast the first part of the week was favorable, but the latter part was much too cool, with injurious frosts in the eastern parts of Oregon and Washington.

Corn made slow growth over most of the corn belt, and suffered injury from frost in the Ohio Valley and Lake region. In the States of the lower Missouri Valley the crop was much in need of cultivation, warmth, and sunshine. Planting was nearing completion in the more northerly sections.

Winter wheat made favorable progress in the States of the Missouri and upper Mississippi valleys, and in portions of the lower Ohio Valley, and a general improvement was reported from the upper Lake region. Some complaints of rust were received from portions of Kansas, Oklahoma, and Missouri, and of lodging in the last-named State. In Tennessee, Kentucky, the upper Ohio Valley, and the Mid-

dle Atlantic States the previously reported unfavorable condition continued, thin stands and heading low being generally indicated.

Cool nights checked the growth of cotton throughout the central and eastern portions of the cotton belt, but the general condition of the crop was promising, the least favorable reports coming from the Carolinas. Over the western districts, outside of Texas, the unfavorable effects of low temperatures were less marked. In Texas the crop continued in excellent condition, but in Oklahoma and Arkansas it suffered from lack of cultivation.

June 9.—Although this week averaged somewhat cooler than usual in portions of the Lake region and northern New England, where light frosts occurred, the temperature conditions were generally favorable in the districts east of the Rocky Mountains, and also in the middle and south Pacific coast regions. The States of the lower Missouri Valley again suffered from excessive rains, which also interrupted farm work in the northern portions of Illinois and Indiana and the southern portions of Wisconsin and Michigan. Rain was generally needed along the Gulf and Atlantic coasts from Texas to southern New England, and drought was becoming serious in the Carolinas and in the central and west Gulf districts.

With ample moisture and favorable temperatures corn made good growth throughout the central valleys, but was much in need of cultivation in the States of the lower Missouri Valley and Wisconsin. In the lower Ohio Valley and Tennessee the crop was well cultivated and in promising condition, but in the central and west Gulf States it suffered much from drought.

The warm, showery weather was favorable to the development of rust in winter wheat in portions of Missouri and Indiana, and lodging occurred to some extent in Illinois and Missouri. With these exceptions a general improvement in the condition of the crop was indicated. Harvesting was in progress as far north as North Carolina, Tennessee, and the southern portions of Missouri and Kansas. On the Pacific coast the wheat outlook continued promising, although grasshoppers caused some damage in the Sacramento and San Joaquin valleys. Spring wheat made rapid growth throughout the spring wheat region, except in lowlands, where it suffered from excessive moisture.

In the States of the Missouri and upper Mississippi valleys and Lake region oats made good progress, although too rank growth was reported from portions of Illinois, Iowa, Minnesota, and Wisconsin. In the upper Ohio Valley, Middle and South Atlantic, and east Gulf States an inferior crop was indicated.

FAVORABLE TEMPERATURES AND ABUNDANT RAINS—WHEAT HARVEST IN PROGRESS.

June 16.—Highly favorable temperature conditions prevailed during this week in the great corn States of the central valleys, but the central and west Gulf States suffered from excessive heat, and the districts from the upper Missouri Valley to the New England coast experienced temperatures too low for favorable growth. The lower Missouri and upper Mississippi valleys, and the southern portion of the upper Lake region, where in previous weeks farm work was interrupted by heavy rains, received additional heavy rains, and crops in portions of these districts were much in need of cultivation. Abundant rains effectually relieved drought in the South Atlantic States, but the almost entire absence of rain in the central and west Gulf States intensified drought conditions previously existing in those sections. Weather conditions on the Pacific coast were favorable, except in Oregon and Washington, where the nights were too cool.

Corn made rapid growth in Nebraska, Kansas, Missouri, Indiana, and in portions of Illinois and Iowa, and improved much in Ohio. In portions of Iowa and northern Illinois the crop suffered from heavy rains, and in Wisconsin and Michigan from both excessive moisture and low temperatures. In Kentucky, Tennessee, and generally throughout the Middle and South Atlantic States corn did well, but suffered seriously from drought in the central and west Gulf States.

Winter wheat made generally favorable progress, further improvement being reported from the Ohio Valley and Lake region. In northern Illinois the crop suffered to some extent from heavy rains, and much lodging on rich soils was reported from Wisconsin. Harvest began in Kansas and southern Illinois, progressed under favorable conditions in Missouri, being about finished in the Carolinas and Tennessee. Spring wheat was damaged in flooded valleys in portions of Iowa, but did well in the drier portions of the State, and some of the late sown in South Dakota was weedy. With these exceptions, the crop was in excellent condition throughout the spring-wheat region.

Oats suffered some injury in northern Illinois and portions of Iowa from heavy rains, and too rank growth was reported from Nebraska and Wisconsin; elsewhere throughout the central valleys and Lake region the crop advanced favorably.

Over the northern portion of the western and central districts and generally throughout the eastern portion of the cotton belt cotton experienced generally favorable conditions, although lice caused injury in portions of South Carolina and Georgia. Over the southern portion of the central districts and throughout Texas the crop made slow growth, and lice infested many fields in Mississippi and Louisiana. Rain was now urgently needed in these last-mentioned districts, especially in Texas, where, however, despite adverse conditions, the crop did well.

The season to date was very unfavorable for transplanting tobacco in the Middle Atlantic States and Kentucky, and this crop suffered much from drought in Virginia, North Carolina, and portions of Kentucky.

LOW TEMPERATURES AGAIN CHECK GROWTH—CONTINUOUS RAINS IN THE GREAT VALLEYS.

June 23.—This week was abnormally cool in all districts east of the Rocky Mountains, except along the South Atlantic and Gulf coasts. More or less damaging frosts occurred in the central and northern Rocky Mountain districts, the Dakotas, Minnesota, and portions of Iowa and New York. Local showers afforded relief in portions of the central Gulf States and over very limited areas in Texas, but in much the greater part of that State no rain fell and high temperatures prevailed. Portions of the lower Missouri Valley and lower lake region continued to suffer from excessive rains. The conditions on the Pacific coast were favorable, notwithstanding the prevalence of hot, drying winds in Washington.

The unseasonably low temperatures checked the growth of corn over the northern portion of the corn belt, and cultivation was retarded by rains in portions of the upper Ohio Valley, upper Lake region, and upper Missouri Valley. In the lower Missouri Valley, Oklahoma, Kentucky, Tennessee, and the Middle and South Atlantic States corn made favorable progress; but in the central and west Gulf States the early planted was seriously injured by drought.

Winter-wheat harvest was delayed by rain in the lower Missouri Valley, but progressed favorably in the Ohio Valley and Middle Atlantic States. This crop experienced no unfavorable conditions during the week, although low temperatures checked ripening over the northern portion of the winter-wheat States. In Oregon and Washington hot, drying winds prevailed, but wheat escaped injury, and in California harvesting continued under favorable conditions. Spring wheat made excellent progress generally throughout the spring-wheat region and was heading in the more northerly portions. Too rank growth, however, was reported from Wisconsin and Iowa, with a tendency to rust in the last-named State.

The general outlook for oats continued promising in the States of the central valleys and Northwest, although rank growth and lodging were reported from the central Missouri and upper Mississippi valleys. In Arkansas, Tennessee, and western Kentucky prospects were lessened by drought. Harvesting was begun as far north as southern Kansas and Virginia.

As in the previous week cotton experienced favorable conditions over the northern portion of the central and western districts, and generally throughout the eastern portion of the cotton belt; lice, however, were more extensively reported, and some fields in South Carolina were grassy. With very little rain in Texas and only scattered showers over the southern portion of the central districts, the growth of cotton was checked, especially in Louisiana and Texas, and in the last-named State shedding, blooming to top, and unsatisfactory fruiting were reported, but lice and boll weevil were less numerous.

A general improvement in the condition of tobacco was reported, especially in the Carolinas, Tennessee, and Maryland.

June 30.—The northern portions of the country east of the Rocky Mountains experienced another decidedly cool week, with generally abundant rainfall, but in the Southern States the week averaged warm, with phenomenally heavy rains, where they were greatly needed, over a large part of Texas and portions of northern Louisiana and southern Arkansas. Much-needed rains also occurred in portions of the central Gulf districts, Tennessee, and the Middle Atlantic States, but drought conditions began to be quite seriously felt in the east Gulf States. Violent local storms caused a large amount of damage in central Indiana and southern Ohio. On the Pacific coast the week was too cool for favorable growth in Washington and Oregon, but satisfactory conditions prevailed in California, where all crops were maturing rapidly and harvest was in general progress.

The continued low temperatures throughout the corn belt checked the growth of corn and heavy rains interrupted cultivation over large areas, these unfavorable effects being more general over the northern portion of the principal corn

States, where warm sunshine and dry weather were greatly needed, especially in the Lake region and upper Mississippi Valley. Corn was in excellent condition in Kansas, Missouri, Kentucky, Tennessee, and in the South Atlantic States, and while rains greatly benefited late corn in the west Gulf districts, the early planted was in very poor condition.

Over the southwestern portion of the winter-wheat belt the bulk of the winter-wheat crop was cut, but harvesting was much delayed over the northern portion of the western districts and generally throughout the eastern portion. In portions of the central and upper Ohio Valley the crop sustained serious damage from local storms. Cool, moist weather checked ripening over the northern portions of the winter-wheat region, and lodging was reported from some districts. On the north Pacific coast wheat made favorable progress, except in eastern Washington, where rain was needed. The general condition of spring wheat was promising, although its advancement was somewhat checked in portions of the spring-wheat region. Considerable lodging resulted from high winds in eastern South Dakota, and some rust was reported from southern Minnesota. The crop was heading in the southern portion of the spring-wheat region.

Cotton continued to suffer for rain in the south-central portion of the cotton belt, and drought conditions rapidly developed over the greater part of Georgia, where the crop was in less favorable condition than in the previous week. Over the northern portions of the central and eastern districts more favorable conditions existed, although lice were extensively reported throughout the central and eastern portions. The feature of this week was the abundant rainfall over the greater part of the drought region of Texas, where the condition of cotton was greatly improved. Drought, however, continued in extreme northwestern and southwestern Texas. Haying was very generally interrupted and considerable hay damaged in the central valleys by heavy rains, which, however, were favorable for the growth of grass.

MORE FAVORABLE TEMPERATURES EAST OF ROCKY MOUNTAINS—DROUGHT IN GULF STATES—PROGRESS OF WHEAT HARVEST.

July 7.—The northern portions of the country east of the Rocky Mountains that suffered from low temperatures during the last half of June, with the exception of New England, experienced more favorable temperatures. The Missouri and upper Mississippi valleys, Lake region, Middle Atlantic States, and New England received abundant rains, which proved unfavorable in the Missouri and upper Mississippi valleys and portions of the Lake region and Middle Atlantic States. Drought continued with increasing severity over a large part of the central and east Gulf districts, and rain was much needed in the South Atlantic States, where the week was unusually warm, with showers over limited areas only. Texas experienced a week of very favorable temperatures, with scattered showers and more than usual cloudiness—conditions favorable to the conservation of the abundant rainfall of the previous week. In the Rocky Mountain, Plateau, and north Pacific coast districts remarkably low temperatures prevailed, with unusual precipitation, much in the form of snow in the northern districts, and general frost and freezing temperatures in Nevada and Utah. On the north Pacific coast the week was too cool and wet, but in California the conditions were generally favorable.

Under highly favorable temperatures there was a general improvement in the condition of corn throughout the central valleys, although in the States of the Missouri Valley it suffered considerably from lack of cultivation, due to excessive moisture. In the Southern States a very poor crop was indicated, and in portions of the central Gulf districts the early planted was injured beyond recovery.

The unfavorable harvesting weather of the previous weeks in the States of the lower Missouri Valley continued, although harvesting of winter wheat was now practically finished in that section. Harvesting continued in the Ohio Valley under generally favorable conditions, was practically finished over the southern portion of the Middle Atlantic States, and had begun in the Lake region. Spring wheat experienced no unfavorable conditions, and the outlook for this crop was generally very promising.

With showers over local areas only and very high temperatures, the cotton crop over the greater portion of the central and eastern districts of the cotton belt materially deteriorated, especially over the southern portion of the districts named. In Texas cotton showed further improvement and made good growth, except in the southwestern and northwestern counties, where it was at a standstill.

July 14.—Very favorable temperatures prevailed during this week in all districts east of the Rocky Mountains with the exception of the central and east Gulf States, which suffered somewhat from excessive heat. A considerable portion of these last-mentioned States, however, received much-needed rain, relieving to a great extent the severe drought that had prevailed for several weeks, although more rain was greatly needed in some sections. Heavy rains continued in the Missouri and upper Mississippi valleys and portions of the Lake region, delaying cultivation and causing destructive freshets in places. The central and southern Rocky Mountain regions suffered somewhat from low temperatures and frosts. Highly favorable conditions prevailed on the Pacific coast, especially in Oregon and Washington.

The corn crop, as a whole, in the principal corn States made very favorable progress, although needing cultivation in portions of the Missouri and upper Mississippi valleys and Lake region, as a result of continued rains. In the Southern States late corn improved somewhat. In New England, New York, and North Dakota corn was very backward.

Winter wheat harvest was nearing completion, except in the northern portion of the winter-wheat belt. The crop experienced generally favorable conditions, except in the Missouri Valley, where complaints continued of sprouting in stack and shock. Spring wheat was now heading in the northern portion of the spring-wheat region, and the general outlook for this crop continued promising, although it was late in portions of northern Minnesota.

Oats continued in promising condition, but lodging was reported quite extensively in Nebraska and Iowa, and to some extent in Ohio. Harvesting was interrupted by wet weather in the lower Missouri Valley, but made good progress elsewhere.

There was a general improvement in the condition of cotton, although in the central and eastern districts the plant was small, and blooming to top was extensively reported. In Texas, except in the region of drought, which comprises less than 10 per cent of the cotton area, the crop made rapid growth, and in many sections the prospects were flattering.

This week was favorable for haying, except in portions of the Missouri Valley, where it was retarded by rains.

July 21.—The lower Missouri and upper Mississippi valleys and Lake region continued to suffer from excessive rains, which also interrupted farm work in the Ohio Valley and in portions of the Middle Atlantic States and New England. Much injury to crops and other property resulted from overflows in Iowa and portions of Illinois, Missouri, and Michigan. Drought was largely relieved in the Southern States, but extensive areas in that section were still much in need of rain, especially from Oklahoma eastward to the Carolinas. The temperatures were generally favorable, although rather low in the northern Rocky Mountain districts. The north Pacific Coast States sustained considerable damage from high winds and the Dakotas and Minnesota from hailstorms in scattered localities.

The corn crop made splendid progress in the States of the central valleys, except in Iowa and limited portions of Missouri and Illinois, the condition of the crop in Iowa being fairly good on well-tilled uplands, but great damage resulted from floods on the river bottoms of the southern and eastern portions of that State and also in northern Illinois. Highly favorable reports were received from Nebraska, Kansas, and the greater part of Missouri and Illinois, and a decided improvement in the condition of the crop in the Ohio Valley was indicated.

Rains interfered with the harvesting of winter wheat where unfinished in the extreme northern districts, and were also unfavorable for thrashing in the central valleys, while considerable wheat in shock in the Lower Missouri Valley was damaged. Harvesting continued in California, and had begun in Oregon, where wheat was filling nicely. The crop in both Oregon and Washington, however, sustained considerable damage from high winds. Spring wheat advanced favorably in the principal spring-wheat States, but sustained injury in scattered localities from hailstorms.

Oat harvest was finished in the Southern States and was in progress in the central valleys, and while lodging was extensively reported from the Ohio, upper Mississippi and Missouri valleys, and Lake region, the general condition of the crop continued satisfactory.

Although generally improved in condition, cotton continued to suffer from drought in portions of the Carolinas, over the north central portions of the cotton belt, and in extreme northwestern and southwestern Texas.

Haying was interrupted and much hay spoiled by rains in the lower Missouri and upper Mississippi valleys and portions of the Lake region.

SEVERE DROUGHT IN SOUTH ATLANTIC AND EAST GULF STATES—HEAVY RAINS IN TEXAS.

July 28.—Drought of considerable severity prevailed from Virginia and the Carolinas westward over Kentucky, Tennessee, and the northern portion of the central and east Gulf States, including eastern Arkansas, southeastern Missouri, and the southern portions of Illinois and Indiana, while heavy and damaging rains continued in Texas, portions of the Missouri Valley, and lower Lake region. Rains were generally badly needed in the central and southern Rocky Mountain districts. The temperature conditions were highly favorable, except in New England, New York, and Texas, where the weather was too cool, and in California, where excessive heat caused some deciduous fruit to ripen faster than it could be handled.

The corn crop experienced another week of exceptionally favorable conditions over much the greater part of the principal corn area, the least favorable reports being received from southeastern Missouri and southern Illinois, where the crop was being injured by drought.

Showers prevented the completion of winter-wheat harvest in the Lake region, New England, and the northern portion of the Middle Atlantic States, where damage to wheat in shock was quite extensively reported; elsewhere harvesting was completed, except on the Pacific coast Late spring wheat ripened rapidly in the northern portion, and harvesting began in the southern portion of the spring-wheat region.

The northern portions of the eastern and central districts of the cotton belt continued to suffer from drought, especially on uplands. Outside the drought area in the districts named cotton made very favorable progress. General and heavy rains in Texas were very beneficial in western counties, but they were not needed elsewhere in that State. These rains caused very rapid growth, but considerable damage by boll weevil, bollworm, and shedding was reported.

August 4.—The drought prevailing in the previous week from Virginia and the Carolinas westward to Arkansas was largely broken, the rains being excessively heavy over the western part of the region named. Drought, however, continued in portions of the lower Ohio Valley, the Carolinas, and northern Georgia. The central and northern portions of Texas again received very heavy rains, and the Lake region and the northern portion of the Middle Atlantic States also suffered to some extent from excessive moisture. The protracted drought in the central and southern Rocky Mountain districts continued with increased severity, and portions of Kansas, Nebraska, and the north Pacific coast region were in need of rain. Generally the temperature conditions were highly favorable.

As a whole, corn made excellent progress in the principal corn-producing States.

Some winter wheat remained to be harvested in extreme northern districts, where harvesting was much delayed by rains, and considerable damage was done to wheat in stack and shock. Harvesting was in general progress on the north Pacific coast under favorable conditions. In North Dakota high winds and hail lodged and damaged spring wheat slightly, and rust appeared on the late sown. The crop ripened very rapidly in the Dakotas, somewhat too rapidly in South Dakota, and harvest began in extreme southern North Dakota. In Oregon and Washington spring wheat made favorable advancement.

Oat harvest in the northern districts progressed under more favorable conditions than in the previous week, and was nearing completion, except in the more easterly sections.

A very general improvement in the condition of cotton occurred. The Carolinas, portions of Georgia, Louisiana, and Missouri, however, continued to suffer from drought, and shedding and rust were more or less extensively reported in the central and eastern districts. In Alabama, Mississippi, Tennessee, and Arkansas the rainfall was generally ample. Central and northeastern Texas, in common with Arkansas and the northern portions of Louisiana and Mississippi and western Tennessee, received during the forepart of the week from 2 to 10 inches of rain. In Texas cotton made heavy bush, and, as a rule, continued to fruit satisfactorily, but there was considerable complaint of shedding, boll worms, and weevil, especially in the lower portions of the Brazos and Colorado valleys.

August 11.—Portions of Virginia, the Carolinas, Georgia, Tennessee, northern Alabama, southeastern Missouri, and the lower Ohio Valley continued to need rain and drought conditions developed to some extent in portions of Nebraska, South Dakota, and northern Wisconsin, but the principal agricultural districts elsewhere east of the Rocky Mountains experienced very favorable conditions with

respect to moisture, with the exception of portions of the Lake region, Middle Atlantic States, and New England, where too much rain fell. The temperature conditions were favorable, except over the northern portions of the Missouri and upper Mississippi valleys, where it was too cool during the latter part of the week, with light frost in Minnesota and eastern South Dakota, while some injury was caused by excessive heat in Kansas and Oklahoma in the early part of the week. On the Pacific coast the week was hot and dry, and while the conditions were favorable for harvesting they were detrimental to growing crops in Oregon and Washington.

The corn crop as a whole experienced another very favorable week, although portions of southeastern Missouri and southern Illinois suffered severely from drought, and late corn in Oklahoma and Kansas sustained some injury from excessive heat.

Spring-wheat harvest neared completion in the southern portion of the spring-wheat region, and advanced rapidly in the central and northern portions, though a considerable part of the crop in the Red River Valley was still very green.

Oat harvest was practically finished, except over limited areas in extreme northern districts, and while a generally heavy crop was secured, the quality in many sections was impaired after being in shock.

With a general absence of rain in Texas and only scattered showers over the central portions of the middle and eastern districts of the cotton belt, the progress of the cotton crop as a whole was favorable. Complaints of rust and shedding, however, were quite general, and some premature opening was reported from portions of Georgia and South Carolina. Uninterrupted sunshine and high temperatures checked the ravages of boll worms and weevil in Texas, but these pests continued to cause damage.

CORN MATURES SLOWLY—DETERIORATION OF COTTON.

August 18.—This week was not favorable for the rapid maturing of crops in the northern districts eastward of the Missouri Valley, where the weather was abnormally cool, with excessive rains in portions of the Missouri and upper Mississippi valleys, while hot and generally dry weather prevailed in the Southern States, and the protracted drought continued in the middle Rocky Mountain districts. Drought was relieved in Washington, and generally favorable conditions prevailed in the Pacific coast States, although the week was unseasonably cool in that region, and showers interrupted grain harvest in Oregon.

Corn continued in very promising condition in the principal corn States, in the more northerly portions of which, however, it matured slowly.

Late cotton improved in the Carolinas, Mississippi, and Louisiana, and in portions of Missouri and Tennessee. In Alabama and Florida a light crop was indicated, and in Georgia the outlook was so varied as to range from excellent to almost a complete failure. Rust and shedding were very generally reported throughout the belt, with premature opening in portions of Alabama, Georgia, and South Carolina. In Texas cotton opened rapidly and picking became general, but the crop deteriorated on account of excessive heat, shedding, and ravages of boll worms and weevil.

August 25.—As a whole, the weather conditions east of the Rocky Mountains were not favorable, being too cool in the northern districts eastward of the Missouri Valley, with too much moisture in portions of the central valleys, while excessively hot in the Southern States, with drought of greater or less severity throughout the cotton belt. Although cool, the conditions were fairly favorable for maturing crops in the Ohio Valley and over the southern portion of the Middle Atlantic States, as well as on the Pacific coast.

Corn greatly needed warm, dry weather throughout the northern portion of the corn belt, where the abnormally cool weather of the two preceding weeks greatly retarded its growth. Over the southern portion of the corn belt an excellent crop of early corn was now practically assured. In portions of Iowa and central Illinois corn was badly lodged as a result of local storms.

Spring-wheat harvest was unfinished in the northern portion of the Red River Valley, where it was interrupted by frequent showers, which also seriously interfered with stacking and thrashing. Sprouting and rotting in stack and shock were reported from Iowa, and in southern Minnesota thrashed wheat was injured.

A decided deterioration in the condition of cotton occurred generally throughout the central and western portions of the cotton belt, as well as over a large part of the eastern districts.

September 1.—The temperature conditions in the northern districts east of the Missouri Valley during this week were more favorable for maturing crops than in the previous week, but, as in the two weeks immediately preceding, excessively high temperatures prevailed in the central and west Gulf districts, including Oklahoma and Indian Territory. Excessive rains continued in the lower Missouri and Red River of the North valleys, to the serious detriment of grain in shock and stack, and with temperatures slightly below normal in the Missouri Valley the maturity of crops advanced slowly. Continued absence of rain intensified the drought in the west Gulf districts, and rain was generally needed in the Ohio Valley and in coast districts from southern New England to the Carolinas. Generally abundant rains have relieved drought conditions in the east Gulf districts. Frost, with ice in exposed places, occurred in the northern Rocky Mountain region on the morning of August 29. Generally favorable conditions prevailed on the Pacific coast, although rather cool during the forepart of the week. The week was practically rainless over the greater part of Louisiana and in portions of Arkansas and Oklahoma and throughout Texas, with the exception of a few light showers in the north-central and northeastern portions, the result of which, with the ravages of insects, was a steady deterioration in the condition of cotton. The central and eastern districts of the cotton belt, with the exception of portions of the Carolinas where drought continued, received abundant rains, causing considerable injury to open cotton.

September 8.—Although this week was cool in the central valleys and Lake region with more than the average rainfall in portions of the upper Mississippi Valley, the maturing of crops made generally favorable, though not rapid, advancement. The greater part of Texas, in which State severe drought prevailed at the close of the previous week, received abundant rainfall, and drought conditions in the Middle Atlantic coast districts were also largely relieved, but the interior of the Middle Atlantic States, Ohio Valley, and portions of the lower Lake region and South Atlantic States continued to need rain. Light to heavy frosts were very general in the northern districts from Montana to the New England and the Middle Atlantic States from the 3d to the 6th, with but slight injury. Rain was much needed in Washington and Oregon, but otherwise the general conditions on the Pacific coast were favorable.

Notwithstanding the prevalence of low temperatures throughout the corn belt, and copious rainfall in portions of the upper Mississippi Valley, the corn crop made very satisfactory advancement toward maturity, wholly escaped injury in the States eastward of the Mississippi River from frosts occurring on the 4th and 5th, and sustained but slight injury in the States to the westward. The bulk of the corn crop in Missouri and Kansas and much of the early planted in Nebraska and the States of the Ohio Valley was now safe.

Texas and a large part of the central and eastern districts of the cotton belt received abundant rainfall, and cotton opened more rapidly than it could be picked.

UNSEASONABLY COOL—LIGHT RAINFALL AND DAMAGING FROSTS.

September 15.—This week was unseasonably cool throughout all districts east of the Rocky Mountains, more particularly in the Lake region, Central valleys, and Gulf States, with a general absence of rain, or only light precipitation over the greater part of the area west of the Mississippi River, although heavy rains occurred in portions of Arkansas and Louisiana. Needed rains fell in the Ohio Valley, Lake region, and Middle and South Atlantic States, effectually relieving the drought conditions in those districts. More or less damaging frosts occurred on the 12th, 13th, and 14th throughout the Northwest, Central valleys, and Lake region, and as far south as Arkansas and the northern portions of Mississippi, Alabama, and Georgia. The North Pacific coast States continued to need rain, but in other respects the conditions on the Pacific coast were favorable.

Late corn was seriously damaged by heavy frosts over the northern portion of the corn belt, more especially to the westward of the Mississippi River. Ohio, Indiana, Illinois, Missouri, and Kansas escaped injury, except in the northern portions, where late corn was damaged.

The weather conditions were favorable for thrashing spring wheat throughout the principal spring-wheat States, except in North Dakota, where high winds interrupted this work to some extent.

The very cool weather checked the opening of cotton in the central and western portions of the cotton region. Picking, however, advanced rapidly generally throughout the belt, and, as a rule, under favorable conditions.

Rains caused damage to open cotton in portions of Arkansas, Louisiana, Georgia, Florida, and South Carolina.

September 22.—The temperature conditions were generally favorable in all districts east of the Rocky Mountains, although the week was decidedly cool in the South Atlantic States and Missouri Valley. Heavy rains retarded work in Florida, portions of the central and west Gulf States, and portions of the upper Mississippi and Missouri valleys, while a large part of the Middle and South Atlantic States needed rain for fall plowing and pasturage. The middle and southern Rocky Mountain districts received abundant and much-needed rains. The week was generally cool on the Pacific coast, with rainfall slightly in excess of the average in portions of Oregon and Washington. Frosts occurred in the Rocky Mountain districts, Missouri and upper Mississippi valleys, and Lake region, but were less damaging than those of the previous week. No further material damage by frost was sustained by the corn crop. The reports indicated, however, that the frosts of the 12th and 13th caused very serious injury over the northern districts. Over the southern portion of the corn belt an exceptionally fine crop was assured.

In Florida, Texas, and portions of Louisiana and Mississippi rains caused considerable damage to open cotton, but were of considerable benefit to the late planted in Texas and Oklahoma.

September 29.—As a whole this week was very wet in the districts east of the Rocky Mountains, with temperatures generally above normal except over the middle Rocky Mountain slope, where it was moderately cool. While the excessive rains interrupted farm work and delayed the maturing of late crops they proved favorable for germination of fall-sown grain and placed the soil in fine condition for plowing and seeding. No damage resulted from frosts, which were confined to the central and northern Rocky Mountain districts and extreme north Pacific coast regions. The general conditions on the Pacific coast were favorable, although rain was needed in eastern Oregon.

The weather was very unfavorable for maturing late corn in the central valleys and Lake region, especially over the northern portion of these districts, and corn in shock was considerably damaged by dampness and mold over a wide area.

Injury from rain to open cotton was very general throughout the belt, with the exception of the Carolinas and portions of Texas, and sprouting and rotting in bolls were largely reported, especially in the central districts. Picking, though much interrupted, was nearing completion in some districts. Late cotton in central and northern Texas made rapid growth.

OCTOBER.

The month, as a whole, was very mild, with rainfall generally sufficient; and, while rain was excessive over a large part of the Atlantic coast and Gulf districts, but little injury resulted therefrom, except in the early part of the month. In the central valleys the conditions were generally favorable for hardening corn, but a considerable portion of the crop in the Lake region and over the northern portions of the Mississippi and Missouri valleys was yet soft.

Rains caused considerable injury to cotton during the early part of the month, especially in the central and western portions of the belt. The weather of the middle and latter part of the month was more favorable, and the development of a fair top crop in some localities resulted. At the close of the month picking was still in progress, with favorable prospects for top crop in northern and central Texas.

Winter wheat seeding made satisfactory progress and was largely completed by the close of the month in the principal winter wheat States. The early sown, as a rule, germinated well, good stands being generally reported. Flies, however, were quite extensively reported from the States of the Ohio and central Mississippi valleys.

Average daily temperature departures (degrees Fahrenheit) for season of 1901 from normal based upon observations for many years, by sections.

Sections.	From Jan. 1 to Mar. 31, inclusive.	For weeks ended— April— 7.	April— 14.	April— 21.	April— 28.	May— 5.	May— 12.	May— 19.	May— 26.	June— 2.	June— 9.	June— 16.	June— 23.	June— 30.
Middle and South Atlantic States	−1.6	−4.3	−1.7	−4.5	+5.2	+5.7	+1.3	+2.3	+4.0	−2.7	+0.8	+0.9	−2.2	−2.7
Gulf States	−2.0	−1.7	−2.5	−2.3	+3.5	+6.3	+2.3	+3.8	+7.7	−0.2	+3.5	+3.6	0.0	+1.6
Ohio Valley and Tennessee	−2.1	−6.9	−5.5	−3.6	+5.1	+8.8	+0.4	+4.1	+9.3	−4.9	+2.3	+3.6	−6.6	−5.4
Lake region	+2.0	−1.4	−0.6	+2.0	+4.7	+5.0	−4.1	+0.3	+6.7	−2.1	+0.4	+0.9	−6.6	−2.3
Upper Mississippi and Missouri valleys	+2.0	−5.2	−4.3	+0.7	0.0	+8.8	+0.4	+7.2	+8.9	−0.7	+2.1	+2.5	−10.7	−8.6
Rocky Mountain region	+2.1	+1.7	−0.6	+3.2	−0.8	+3.4	+4.3	+3.0	−1.2	+1.1	+1.8	+3.5	−2.8	−0.8
North Pacific coast	+0.9	+1.3	−3.3	+3.0	−3.0	−3.7	+5.3	−3.0	−1.0	−1.3	−1.7	−1.3	+5.0	−1.0
California	−0.4	0.0	−0.2	+0.4	−5.0	−3.4	+1.8	−2.6	−3.6	−4.8	0.0	+0.2	+1.8	+1.4

Sections.	For weeks ended— July— 7.	July— 14.	July— 21.	July— 28.	August— 4.	August— 11.	August— 18.	August— 25.	September— 1.	September— 8.	September— 15.	September— 22.	September— 29.
Middle and South Atlantic States	+3.8	−0.5	+1.8	−2.6	+1.8	+1.5	−2.1	−1.0	−0.9	0.0	−4.1	−3.2	+4.1
Gulf States	+2.5	+1.1	+0.9	−2.3	−0.5	+2.3	+3.3	+4.5	+3.5	+0.4	−7.3	−0.7	+2.8
Ohio Valley and Tennessee	+2.9	−0.5	+2.0	−1.4	+2.0	−0.5	−2.5	0.9	+2.3	−2.9	−9.0	−0.3	+5.6
Lake region	0.9	+0.7	−0.9	+0.9	+2.1	−3.6	−4.5	−3.7	+3.0	−2.9	−5.1	+1.7	+1.9
Upper Mississippi and Missouri valleys	+0.4	−2.1	0.0	−0.8	+4.4	−3.0	−1.2	−1.2	+0.2	−3.5	−9.3	−2.3	+0.9
Rocky Mountain region	−5.6	−2.5	−2.5	−0.8	+3.1	−0.2	+0.5	+3.0	+2.1	+1.4	−2.0	−2.0	−0.2
North Pacific coast	−7.7	−2.3	+2.7	+2.7	−1.0	+9.0	−3.3	0.0	−2.3	+1.0	+5.0	−3.0	−2.3
California	−4.6	+1.0	−0.4	+2.6	+0.4	+0.2	−3.2	−2.3	−0.6	+3.8	+1.4	−1.4	−0.2

Precipitation departures (inches and hundredths) for the season of 1901 from normal, based upon observations for many years, by sections.

Sections.	From Jan. 1 to Mar. 1, inclusive.	For weeks ended—												
		April—				May—				June—				
		7.	14.	21.	28.	5.	12.	19.	26.	2.	9.	16.	23.	30.
Middle and South Atlantic States	−0.94	−0.60	+0.21	−0.31	−0.63	+0.12	−0.25	−0.51	+0.13	−0.54	−0.57	+0.63	+0.12	−0.17
Gulf States	−1.71	−.38	+.32	−.82	−.81	−.72	−.28	+.27	−.85	−.73	−.93	−1.01	−.43	−.84
Ohio Valley and Tennessee	−4.22	−.22	−.55	−.74	−.69	+.40	−.53	−.55	+1.33	−.33	−.17	−.20	−.51	+1.97
Lake region	−1.67	−.39	−.12	−.54	+.04	+.29	−.05	−.13	+.63	−.27	+.42	+.61	−.34	+.92
Upper Mississippi and Missouri valleys	−1.92	−.45	−.59	−.63	+.41	+.15	−.24	.00	+.60	−.61	−.39	−.38	−.18	+1.29
Rocky Mountain region	−.42	−.24	+.14	−.17	−.10	+.14	+.04	+.67	+.25	+.37	−.26	−.12	−.19	−.06
North Pacific coast	+1.14	+.37	+.13	−.05	−.41	+.10	.00	+.42	−.33	+.11	−.03	−.39	−.32	+.07
California	+.74	+.01	−.43	−.31	.00	−.22	−.07	+.13	−.13	+.01	−.67	−.67	−.03	−.02

Sections.	For weeks ended—												
	July—				August—				September—				
	7.	14.	21.	28.	4.	11.	18.	25.	1.	8.	15.	22.	29.
Middle and South Atlantic States	−0.76	+0.18	−0.48	+0.19	−0.21	−0.18	−0.25	−0.73	−0.81	−0.36	+0.28	−0.40	+0.33
Gulf States	−.66	−.65	−.23	+.42	+1.12	−.45	−.79	−.91	−.68	+.11	−.46	−.47	+1.77
Ohio Valley and Tennessee	−.50	−.45	+.02	−.72	+.59	−.23	−.54	−.17	−.48	−.57	−.01	−.18	+.55
Lake region	+1.20	+.03	+1.00	+.03	−.17	−.06	−.31	−.34	−.35	−.46	+.43	−.31	+1.03
Upper Mississippi and Missouri valleys	+.34	+.16	+.39	−.09	−.34	+.27	+.40	+.43	+.45	−.32	−.48	+.25	−.22
Rocky Mountain region	−.65	+.08	+.12	+.23	−.32	−.02	−.19	−.03	−.12	−.05	−.25	+.98	−.04
North Pacific coast	+1.23	−.13	−.07	−.09	−.03	−.05	+.13	−.12	−.10	−.18	−.31	+.08	+.30
California	.69	.00	.00	+.17	.00	−.04	.00	.00	−.02	.03	−.05	−.08	−.11

CHANGES IN LAWS RELATING TO CONTAGIOUS DISEASES OF ANIMALS.

MASSACHUSETTS.

An act approved February 25, 1902, abolishes the board of cattle commissioners which was created by the act of June 19, 1895, and creates in its place the cattle bureau of the State board of agriculture. The chief of the said cattle bureau is appointed by the governor and confirmed by the council, and performs the duties which formerly devolved upon the board of cattle commissioners. His salary is fixed at $1,800, and he is entitled to a clerk at $1,200 and expenses. His orders and regulations must be approved by the governor and council. He is required to make semiannual reports to the State board of agriculture.

An act approved April 11, 1902, appropriates $50,000 "for the extermination of contagious diseases among horses, cattle, and other animals" for the year 1902.

An act approved April 17, 1902, repeals sections 103-104, Revised Laws, relating to the inspection of domestic animals at slaughter establishments.

OHIO.

Sections 4211-9, 4211-13, 4211-15, 4211-16, 4211-17, 4211-18, Revised Statutes, 1897, are amended and 4211-16 is supplemented by act of May 7, 1902.

The State board of agriculture is constituted the board of live stock commissioners to prevent the spread of infectious and contagious diseases among domestic animals and the extermination of the same; and is directed to cooperate with the Bureau of Animal Industry of the United States Department of Agriculture. The old board consisted of three persons appointed by the governor. The new law provides for the appraisement and slaughter of animals affected with or having been exposed to a contagious disease; the old law limited the diseases to pleuro-pneumonia and foot-and-mouth disease. The law also provides for the appointment of a veterinarian, whose compensation is to be fixed by the board of agriculture; for inspection; for penalty for failure to comply with regulations and rules of the board, and for indemnity for animals killed, at their actual value when killed.

An act of May 7, 1903, amends sections 2137 and 2134, Revised Statutes, 1897, empowering board of health to appoint inspectors of dairies, slaughterhouses, etc.; to enter premises; to refuse permits to dealers, and to require veterinary certificate that dairy cows are free from tuberculosis, etc.

GEORGIA.

An act of November 5, 1901, prohibits the importation into the State of any animal having a contagious disease, except distemper.

MARYLAND.

The governor of Maryland is authorized by the act of April 8, 1902, to appoint three persons as a commission "to investigate the cause, origin, treatment, prevention, and cure of the disease in horses called cerebro-spinal meningitis." The commission is required to report the results of their investigations not later than January 1, 1904. Two thousand dollars was appropriated for defraying all expenses.

PLANT DISEASES IN THE UNITED STATES IN 1902.

By W. A. Orton, *Assistant Pathologist.*

This article is compiled from reports furnished by the State experiment stations and from field observations by agents of this Department. It aims to give a brief statement of the prevalence of plant diseases in the United States in 1902 as compared with conditions in previous years, which will be found recorded in the three preceding Yearbooks. It also mentions briefly the more important discoveries in plant pathology which have been published recently in this country, and gives some instances of the year's progress in the successful treatment of important diseases.

The close relation between fungous diseases and the weather conditions is shown in several cases where an unusually wet period has favored the development and spread of destructive parasites, while in other sections dry and sunny weather reduced the loss from diseases which are commonly more harmful. Several epidemic outbreaks are noted as causing unusual injury. Other diseases of our staple

crops which are mentioned as no more prevalent than usual have nevertheless caused heavy losses to the farmers of this country, amounting in the aggregate to many millions of dollars. It is difficult to obtain reliable estimates of the amount of injury done by plant diseases, but the few figures that have been included in this article indicate something of the magnitude of the subject and show the importance of extending a knowledge of remedial measures.

APPLES, PEARS, AND QUINCES.

The bitter-rot of apples has been less injurious in Virginia and Maryland than for several years past, probably on account of the failure of the apple crop; but in West Virginia it was reported to be worse than ever before. In Ohio it has been prevalent, especially on the sweet sorts grown in Belmont County, where it has yielded only partially to treatment; while on the Ben Davis in southern Ohio, where heavy losses were reported one year ago, there has been satisfactory progress in its prevention. In southern Illinois and Missouri it was bad, though probably less severe than usual. Spraying has been partially successful in controlling it. Our knowledge of the life history of this fungus has been increased by G. P. Clinton, of the Illinois Experiment Station, where the permanent stage (*Gnomoniopsis fructigena* (Berk.) Clint.) has been discovered, and material progress in methods of prevention has been made by this Department, especially through the discovery by R. A. Simpson that the infection of the fruit comes from cankers on the limbs of the apple trees.

Apple scab has been epidemic in the north from Maine to Iowa and Nebraska. It was particularly disastrous in the Lake region, New York, and the Champlain Valley, on account of the unusually wet season. Spraying was not so effective as usual and in many cases injured the trees. Heavy losses followed from secondary rotting, favored by the warm and rainy fall. A pink rot, caused by a secondary fungus (*Cephalothecium roseum*) following the scab, was the cause of much complaint. Apples in southern New England were relatively free from these troubles. In Oregon, Washington, and Idaho apple scab was increasingly injurious where it had not been feared before. The perfect form of the scab fungus (*Venturia inæqualis* (Cke.) Ader.) on dead leaves, first observed in Europe some years ago, has been carefully studied by Mr. Clinton at the Illinois station.

The sooty blotch of the apple (*Phyllachora pomigena*) was reported as prevalent in Connecticut and Rhode Island, especially in neglected orchards. The Baldwin brown-spot was very common in Massachusetts but scarce in New York. A fungus brown-spot is reported on Ben Davis in Maryland and another on Baldwins in California. Apple leaf-spot was very abundant in New York, where it was especially bad on Baldwins and Greenings; also in Maryland, in the Piedmont region in Virginia, and the Panhandle of West Virginia. The parasitism of the fungus (*Phyllosticta*) supposed to cause this leaf-spot has been questioned at the New York State station. In upper Virginia the prevalent form of leaf-spot was due to the black-rot fungus (*Sphæropsis*). Rust (*Ræstelia*) on apple leaves and fruit was reported common in Connecticut, Long Island, and the Hudson Valley, Ohio, West Virginia, Kentucky, Arkansas, and Nebraska.

Apple canker was injurious on account of the wet season in New York, Connecticut, Maryland, North Carolina, and South Carolina. At the Nebraska station this fungus (*Sphæropsis*) was shown to attack sumac and other plants. At the Illinois station the prevailing form of canker was found by Hasselbring to be due to another fungus (*Nummularia discreta* Tul.). In the Pacific Northwest black canker occurred as usual. Root-rot, a fungous disease, has continued to destroy apple trees planted after oak forests in West Virginia, Kentucky, Southern Illinois, Missouri, Arkansas, and Oklahoma.

Pear blight (bacterial) did excessive damage to apple trees in Ohio, Iowa, Wisconsin, and North Dakota, in the latter State being especially destructive on Siberian crabs. Pears were greatly injured by it in the Eastern and Southern States, but it was on the whole less severe there than in previous years. Experiments made by this Department in Texas showed that the disease could be successfully controlled in large orchards by proper application of methods previously recommended. In California this blight is spreading rapidly, especially in the San Joaquin Valley. Much damage is done by its development during the warm winters from infection of fall blossoms. In Colorado and Idaho it was also exceedingly destructive, but was not so much so this year in Washington. Plum trees in Vermont were attacked by pear blight and the identity of the two diseases was shown by L. R. Jones of the Vermont station.

Pear scab in New York was exceptionally bad, and leaf-spot (*Entomosporium*) of pear and quince was serious locally. The warm rainy fall had a bad effect on Kieffer pears from Virginia to New York, causing them to rot in storage and transportation. A new pear disease has caused alarm in northern California, and the loquat in southern California has suffered from a bacterial blight which Newton B. Pierce, of this Department, has found may be controlled by proper pruning methods.

PEACHES AND OTHER STONE FRUITS.

Brown-rot of the peach was conspicuously absent in the Atlantic coast States this year, and the peach crop was marketed in fine condition on account of the dry and sunny weather. In New York the early varieties rotted badly, the late ones not so much, while in Ohio and Michigan the main crop was harvested in good condition, but late peaches were greatly injured. Around Catawba Island alone 30,000 bushels were lost.

While, as above stated, peaches escaped, brown-rot was very serious on plums, and to a lesser extent on cherries, in the Eastern and Central States. In Iowa there was complaint of an unusual amount of twig blight on thorn-apples and plums due to this fungus. In California and Idaho apricots and peaches were little harmed by it. There is a strong tendency to continue spraying with Bordeaux mixture for this disease in spite of the injury often resulting. This is especially the case in Georgia and South Carolina. In connection with this problem, the Tennessee station has published the results of a careful study by S. M. Bain of the action of copper on leaves. The perfect form of this fungus (*Sclerotinia fructigena*) has been discovered in this country by J. B. S. Norton at the Maryland station.

Peach yellows in Ohio has occasioned the loss of 60 per cent or more of all the orchards outside of Lucas, Ottawa, and Erie counties. In Michigan it is decreasing on account of the stringent measures taken to stop it, and in Maryland it has not spread, except where the removal method is not practiced. It spreads southward very slowly, though it is now known to occur in North Carolina and South Carolina.

Little-peach has continued spreading in Michigan, but in Niagara County, N. Y., it appears to be on the decline. This Department recommends the destruction of diseased trees.

Peach leaf-curl is widespread and locally injurious, but it is always controllable by a single winter spraying. There has been less scab than usual on the fruit. Powdery mildew was prevalent in eastern Washington and Idaho, but was not serious in California. Root-rot in Texas has killed many peach trees. Crown-gall continues to be severe throughout the country, principally on the peach, Japanese plum, and apple. Nematode injuries to peaches were reported from Mississippi.

Black-spot of plums, a new bacterial disease, has been studied in Michigan by Dr. E. F. Smith of this Department. Black-knot was reported to be more noticeable in Rhode Island, New York, and Maryland, but as a rule seems to be on the decrease, owing to more general cutting out. Cherry leaf-spot (*Cylindrosporium*) was very destructive in New York, Ohio, Kentucky, Iowa, and Nebraska, especially on the English morellos.

SMALL FRUITS.

There has been much complaint of grape rot this year in Connecticut, Rhode Island, New York, Ohio, and West Virginia. The greater part of this is probably due to the black-rot (*Guignardia Bidwellii*). Prevention by spraying, though difficult on account of the weather conditions, was successfully accomplished in Ohio by the experiment station. In North Carolina black rot of grapes, while somewhat severe, was not so destructive as in the two preceding years. Experiments made there by this Department demonstrated that the disease can be controlled by Bordeaux mixture, if properly applied. Powdery mildew was serious in portions of Idaho, especially on the European varieties. Vine diseases caused much loss in California during 1902, being widespread in the Santa Clara Valley, while the California vine disease continues in the southern part of the State and is still spreading.

Strawberries in Massachusetts were attacked by root-rot early in the summer. Leaf-blight (*Sphærella fragariæ*) has on the whole been less prevalent this year.

Raspberry anthracnose was reported to be destructive in New York, Nebraska, and Missouri. Cane blight (*Coniothyrium*) was reported from Connecticut, New

York, Ohio, and North Dakota, but seemed to be less destructive this year than last.

. Blackberries in Colorado have been injured by the fungus *Rhizoctonia*, which also attacks potatoes, peas, and other crops.

Currants in New York were not damaged by anthracnose or leaf-spot, but as usual suffered from cane blight in the Hudson Valley. The leaf-spot of currants and gooseberries occurred to an injurious extent in portions of Iowa, Nebraska, Idaho, and elsewhere.

Cranberry diseases continued as usual, causing the loss of about one-fourth of the crop.

Japanese persimmons were injured in North Carolina by a blight of unknown cause, which attacks especially trees grafted on native stocks.

SUBTROPICAL FRUITS.

Citrous fruits in California were not injured seriously by disease. This Department has studied the black-rot of oranges, due to *Alternaria citri* Ell. and Pierce, and the California station has published a report on orange and lemon rots due to *Penicillium digitatum*. Olive diseases made no marked advance.

FIELD AND TRUCK CROPS.

The epidemic of potato late blight (*Phytophthora*), which began two years ago and was more serious last year, prevailed with greatly increased severity in the Northern States. In Maine, Vermont, and other New England States one-half to one-third of the crop was destroyed. There was great loss from blight of the foliage and rotting of the tubers in New York, except on Long Island; also in northeastern Ohio, Michigan, and to a lesser degree in Pennsylvania and Maryland. Spraying has, as before, been an effective preventive of this disease. In California and the Pacific Northwest no unusual injury was reported. Early blight (*Alternaria*) caused some loss outside of the above sections, amounting to one-third of the crop in North Dakota. It was severe in Louisiana and other Southern States and was reported from Maryland and Michigan. The potato-stem rot (*Rhizoctonia*) occurred in New York, but did little harm. It becomes more destructive as it goes westward. Injury was observed in Ohio, but in North Dakota and Colorado it was extremely destructive in some localities. *Fusarium* stem-rot occurred in Nebraska and Maryland, and a *Fusarium* "summer rot" of the tubers was widespread in South Carolina. In the South the bacterial brown-rot did considerable damage. In Iowa a similar disease took 50 per cent of some crops. Scab occurred as usual. This continues to cause more complaint in the West than in the East, but the disinfection of the seed as a remedial measure is coming into more general use.

Tomatoes from Maryland southward have suffered from the bacterial wilt. A fungous wilt is reported from Maryland, and one in Florida (*Fusarium*) does great injury. Leaf-spot was not reported, except from Nebraska and North Dakota. In Idaho much loss was caused by the unknown disease or "chlorosis" mentioned last year.

Cucumbers in southern New England and New York suffered from the downy mildew. Powdery mildew is reported common in New York greenhouses, the bacterial wilt disease destructive in Massachusetts and Long Island, and leaf-blight general in Louisiana.

Muskmelons or cantaloupes in southern New England suffered from both mildew (*Plasmopara*) and leaf-blight (*Alternaria*), nearly the entire crop being lost. Anthracnose caused complaint in Massachusetts and Minnesota. Leaf-blight was less destructive than last year in Maryland and southward. The Georgia station and others have shown that this disease can be controlled by spraying with Bordeaux mixture. The bacterial wilt was prevalent in Maryland, a *Fusarium* wilt was reported from South Carolina, and a new disease, stigmonose, due to the attacks of aphides, has been described by the Delaware station.

Watermelon wilt continues to prevail in the South, except on new land. A disease supposed to be this is causing much loss in the Ohio Valley in West Virginia and southern Indiana.

Asparagus rust continues to decrease in severity in New England and New York. In Pennsylvania, the eastern shore of Maryland, and the Southern States as a whole, it was somewhat more prevalent this year than last. The epidemic in the Central and Western States is increasingly virulent. Ohio, Kentucky, Minnesota, Iowa, North Dakota, South Dakota, Nebraska, and Missouri report it to be spreading

abundant, and very destructive. Good results from burning the dead tops are reported from Nebraska and Missouri; the latter State reports benefit from spraying also. Rust occurs on asparagus in Colorado, and is reported from many parts of the Pacific coast. From its distribution and severity it has evidently been there for some years. Leopard-spot of asparagus is reported common in Maryland.

Cabbage black-rot was decidedly less abundant this year in the Northern States, though it was very prevalent in Texas on cauliflowers and cabbage. Mildew (*Peronospora parasitica*) was bad on young plants in Maryland.

Onion stem-rot (*Botrytis*) caused great injury in Connecticut, especially to stored onions. The loss in one locality alone is estimated at $90,000. A similar disease was observed in North Dakota. Black-spot (*Vermicularia circinans*) also caused some injury to stored onions in Connecticut.

Complaint of celery blight comes this year principally from Iowa, Nebraska, and North Dakota, where it was abundant and destructive. The two latter States also report trouble with a bacterial soft rot. Lettuce in North Dakota was similarly attacked by a soft-rot.

Carrots in North Carolina were found attacked by nematodes, as are so many garden vegetables in the South.

Sugar-beet diseases occurred as usual. Leaf-spot (*Cercospora*) was more severe than usual, except in New York. In Ohio there was some damping-off in the early season due to *Rhizoctonia*. Curly-top occurred as usual, but root-rot was more destructive, especially in the Middle West.

Cowpea wilt and root-knot in the Southern States were successfully overcome by the use of a resistant variety introduced by this Department.

Alfalfa rust (*Pseudopeziza medicaginis*) was abundant in New York, but less destructive than last year. A root-rot disease has been common in Maryland, and another has continued as usual in Texas and the Southwest. Rust on bluegrass was especially noticed in Nebraska, while ergot has been more abundant on native grasses in North Dakota and Nebraska than for five years before.

A flax-boll disease has been very disastrous in North Dakota, causing a loss estimated at $2,000,000. Flax wilt (*Fusarium lini*) also continues to be quite general, especially on older fields, and the total loss from it equals or exceeds the above estimate.

Ring-spot of tobacco, a local disease in Virginia, has continued as before. Leaf-spot has been rather less prevalent. This Department has published the results of its investigations to date on the mosaic disease.

CEREALS.

Rusts and smuts of wheat and oats were more destructive this year than last. They are particularly injurious in the Western States, where many years of familiarity have led farmers to overlook the enormous losses they cause. In South Dakota the estimated loss from wheat rust was over $10,000,000, while in the State of Washington wheat smut caused a loss of $2,500,000, and a careful examination of many oat fields in Wisconsin one year ago showed the average loss from smut to be 20 per cent of the crop, which means over $7,000,000 per year in that State alone that might have been saved by a simple treatment of the seed. A new ovule blight of wheat is reported from North Dakota, and a scab (*Fusarium*) injured wheat in Nebraska. Corn smut was reported unusually harmful in Ohio and Mississippi.

COTTON.

The wilt disease of cotton (*Neocosmospora vasinfecta*) has continued to cause great loss on sandy lands, while boll-rot and anthracnose (*Colletotrichum*) did considerable local injury, especially on the heavier soils. Rust injured cotton on worn-out land as usual. Cotton root-rot in Texas continued as in previous years.

NUTS AND FOREST AND SHADE TREES.

Walnut bacteriosis spread in California, but the loss was smaller than last year owing to climatic influences. Pecans in the South Atlantic States were affected by a disease of the branches and another of the nuts. A disease of the black locust, due to *Polyporus rimosus*, has been found to cause extensive injuries in the Eastern United States, and the hardy catalpa has been found affected by two

diseases—soft-rot (*Polyporus versicolor*) and brown-rot (*Polyporus catalpæ*)—which have been studied by this Department. Sycamore blight (*Glœsporium*) was prevalent in Massachusetts and eastern Maryland, and the leaf-spot of the horse-chestnut (*Phyllosticta*) was abundant in New York. Black-spot (*Rhytisma*) of silver-maple leaves was reported bad in Maryland, and rust (*Æcidium fraxini*) on green ash in Iowa. Cottonwood rust (*Melampsora*) was serious in Iowa and North Dakota, and a seed blight of box elder hinders the propagation of that tree in North Dakota and neighboring States.

GREENHOUSE AND ORNAMENTAL PLANTS.

In New England and the Eastern States greenhouse crops, like carnations, lettuce, etc., have during recent years been increasingly injured by stem-rot (*Rhizoctonia*, etc.) and wilt diseases (*Fusarium*). These were again prevalent this year, but are now successfully controlled by many growers, who sterilize their soil by steam under high pressure. It is noteworthy that this practice is becoming quite general among greenhouse men and others on account of the great gain resulting. Chrysanthemum rust is reported as bad in Maryland, Ohio, and North Carolina, but was not so abundant in Massachusetts. The aster wilt (*Fusarium*) was widespread and destructive, not only in the East, but also in Nebraska and North Dakota. The Massachusetts station has published the results of investigations by R. E. Smith on this disease and on the troublesome yellows disease of the aster. Hollyhock rust was bad in New York. Rose mildew (*Sphærotheca*) has been troublesome in Mississippi, Georgia, North Carolina, and other Southern States. Other complaints received were of phlox and rose mildew from Kentucky, carnation rust and verbena mildew from North Carolina, black spot of rose from Nebraska and Idaho, and violet leaf-spot from Connecticut. A serious injury to roses at Woods Hole, Mass., resulted from the fumes of burning tarred roofing. The foliage was shriveled or fell off and the plants were otherwise injured. The Massachusetts courts allowed $20,000 damages to the owners.

PLANT DISEASES IN OUR ISLAND POSSESSIONS.

In Porto Rico the bacterial blight of the tomato (*Bacillus solanacearum* Erw. Sm.) was prevalent and destructive, causing the loss of nearly all the crop planted. A potato blight (probably *Rhizoctonia solani*) destroyed all plats on the station grounds. Other less serious troubles were the rust of sweet potatoes, an undescribed damping-off disease of coffee seedlings, a lichen on coffee leaves grown in excessive shade, scab on orange nursery stock, and sooty mold of citrous fruits.

In Hawaii the root rot of taro is increasing, the annual loss being estimated at $70,000. The Hawaiian station has published a bulletin giving the results of investigations made there by Sedgwick. A *Fusarium* disease of potatoes is prevalent throughout the islands, and has caused great losses, amounting to 50 or 60 per cent of the total crop.

PROGRESS IN FRUIT GROWING IN 1902.

By W. H. Ragan, *Special Agent.*

The American Cranberry Association estimates the crop of the year at 750,000 bushels, of which 450,000 bushels were grown in the New England States, 140,000 bushels in New Jersey and on Long Island, and 135,000 bushels in the Western cranberry fields.

The ratio of increase in the fruit-growing industry in the United States will appear when it is considered that in 1890 there were in round numbers 193,000,000 fruit trees in orchards, as against 367,000,000 in 1900. The increase in plum trees, 334 per cent, was greater than that of any other class of fruit-bearing trees. The next greatest increase was in pear trees, 246 per cent, while the increase in apple trees amounted to 68 per cent. Since 1900, the greatest demand and inclination to plant seems to be in the line of peach growing. It is now said (March, 1903) that the demand for peach trees for orchard planting greatly exceeds the ability of the nurserymen to supply.

Experiments in the cold storage of fruits by the pomological section of the Bureau of Plant Industry for the purpose of determining the proper condition of fruits when placed in cold storage, the temperatures best adapted to the various fruits, their condition after being exposed to outside temperatures when brought out, etc., which

were begun two years ago, are still in progress, with no definite conclusions reached. Some existing opinions concerning the cold storage of fruit have not been borne out by the facts disclosed by the investigations. The impression that cold-storage fruit decays quickly after exposure to outside conditions has not been proved true in these experiments when the fruit was stored in proper condition and maintained in a low temperature, say 32 degrees. If the storage temperature is much higher than this the process of ripening goes on and when the fruit is brought out it soon spoils. Even well colored, yet still hard peaches, when placed in cold storage at a temperature of 32 degrees immediately after being taken from the trees, came out after four weeks in fairly good marketable condition, and remained so for a period of four days. Imperfect and poorly colored specimens, however, soon failed on exposure.

The season of 1902 was peculiarly cool, backward, and moist. The blooming of orchard trees was retarded by the cool spring almost or quite three weeks beyond normal in large sections of the orchard districts, especially in the North and East. This cause, however, did not prevent the production of a full average, or even a large crop of fruit, especially of the apple; yet, owing to the development of fungous diseases on account of the excessive moisture of the season, the fruit as a rule has not kept well, as shown by the Department experiments.

It would seem that Kieffer pear growers have found an encouraging outlet for their surplus fruit in the markets of Great Britain. In 1901 the equivalent of 3,000 barrels was shipped to Liverpool, London, and Glasgow. These pears were shipped in common storage, and because of unusual solidity, owing to the dryness of the season, arrived in good condition and gave satisfactory results. In 1902 fully 40,000 barrels were sent to the same markets, those going in ordinary storage, especially when shipped in large packages, generally arriving in bad condition, apparently as the result of their growth in an unusually cool and moist season. A New Jersey grower, however, shipped of the products of his own orchards nearly 40 carloads, which arrived in good condition and brought satisfactory prices. These were shipped in 50-pound boxes, each specimen separately wrapped.

The relation of the cold-storage industry to the apple business is of growing importance. The apple crop of 1901 was comparatively small, yet 1,771,000 barrels were placed in cold storage and 138,000 in common storage. The fruit kept well and sold at unusually high prices. In 1902, 3,128,000 barrels were placed in cold storage and 1,236,700 in common storage. The producers and cold-storage men are alike taking much interest in the investigations being made by the Department of Agriculture to determine the influence of cultural conditions, the most practical methods of handling and of storage, and to demonstrate the keeping qualities and value of our orchard products.

From a summary of results already accomplished by these experiments the following interesting facts have been gleaned:

The temperature of a cold-storage warehouse should be uniform throughout. Fruit should be placed in cold storage immediately after being taken from the tree. A delay of a few hours or a few days, especially in hot weather, will result in serious loss. Pears should be picked at early maturity, but apples keep best when well matured and colored on the tree, but still hard. Fruit keeps best and stands up longest after being brought out if the storage temperature is about 32 degrees. A higher temperature than this promotes ripening while in storage and early decay after being withdrawn. Small packages, say about 50 pounds, are better than larger ones. This is especially true of pears. The ventilation of barrels and large packages is very essential to the quick-ripening fruits. Wrapping prolongs the keeping of fruit, double wrappers being better than single ones. The inner wrapper may be made of porous paper, like unprinted newspaper, the outer one of paraffin paper. Perfect specimens only should be selected for storage; none other will pay.

Two of the hybrid orange seedlings, between the sweet orange and the hardy *Citrus trifoliata*, crossed by Dr. Herbert J. Webber, of the Department Plant Breeding Laboratory, have now produced fruit. Others may be expected to fruit in the near future. The new orange is recognized as a decided improvement over the inedible product of the hardy parent, though by no means entitled to the distinction of a dessert fruit. It promises, however, to prove of value as a substitute for the lemon and lime in the manufacture of summer drinks and also to become the parent of edible fruits of still greater value, for in experiments of this character the best results are not expected from the first generation of hybrids of distinct species. Also two other hybrids, crosses by Dr. Webber—one between the Mandarin and the common sweet orange, the other between the Mandarin and the pomelo—have fruited. The latter is especially interesting. These promising experiments, it is hoped, will give some results for practical use in the near future.

FRUIT EXPORT TRADE.

The importance of developing export trade in fruits as a means of relieving domestic markets of oversupplies finds good illustration in the case of the apple crop of 1902. Though the crop was probably not equal in volume to that of some previous years, the weather at the harvesting time was favorable and a larger quantity of fruit went into storage than has been recorded in any previous year. Although the general quality of the crop was rather low, the fruit went rapidly into export trade and a fair general level of prices was maintained.

The total quantities exported from American ports up to December 27, 1902, in contrast with the corresponding period for 1901, as reported through commercial channels, were as follows:

	Barrels.
Apple exports from American ports to December 27, 1902	1,008,868
Apple exports from American ports to December 27, 1901	269,545

The first trans-Atlantic export shipments of early summer apples ever made from the United States were made in July, 1902, under the direction of the Pomologist. In a series of weekly shipments made during that month from Delaware it was demonstrated that with proper handling delicate summer apples can be safely shipped to London in six-basket peach carriers in refrigeration and arrive in sound condition. Such varieties as Williams, Early Strawberry, and Randolph were found to be especially desired by London buyers, although very high prices were realized for such delicate varieties as Yellow Transparent when carefully wrapped, packed, and handled. Commercial shipments of this class of fruit require quick transportation to the point of exportation in refrigerator cars, with quick transfer of fruit from car to steamship refrigerator. Where these requirements can be met there appears to be a fair prospect of profitable business in this line during July and early August.

A commercial beginning in the exportation of eastern grown Bartlett pears was made in 1902, with generally satisfactory results to shippers, so far as reported. A carload test of western New York Bartletts by the Department, in which fruit of the same grades was forwarded in barrels, boxes, and half boxes, both with and without wrappers, to test the relative merit of the different styles of packing, indicated that on the London market the box and half box of wrapped fruit are very much preferred, the actual net returns on these styles being from 40 to nearly 500 per cent above those from the unwrapped fruit shipped in either half box, box, or barrel.

The way now appears to be open for commercial shipments in this line whenever the difference between the values of Bartlett pears in London and New York will warrant the expense of ocean transportation and refrigeration.

Experimental export shipments of peaches from Georgia, West Virginia, and Connecticut have demonstrated the practicability of delivering in London, in fine condition, firm-fleshed varieties of peaches harvested in those States under favorable conditions. While the net prices received were not in general equal to those obtainable in New York in 1902, the development of methods of forwarding is considered advisable, in order that advantage may be taken of more favorable market conditions in future years.

HAY, PASTURES, AND FORAGE CROPS.

By W. J. Spillman, *Agrostologist.*

The hay crop of the past season has been better than the ordinary, and pastures have been good. This, taken with an abundant corn crop, has enabled the farmers of the Central States to send their cattle to market in better condition than usual. As an after effect of the severe drought of last year better care has been given to meadows and pastures this year, and farmers in many sections of the country have turned their attention to new forage plants. Alfalfa has stood at the head of the list of new forage crops for the Eastern States, and reports indicate its successful culture in practically all of the territory east of the one hundredth meridian except the extreme north. There is reason to believe that this crop will within a few years largely displace even red clover as a leguminous crop.

Almost every season finds some new and unknown forage plant exploited in this country. A number of valuable things have thus been introduced in the past, but most crops which thus become a fad turn out to be of little value. During the past season two such crops have appeared, both exciting very general interest. One is cassava, which began to attract general attention at the end of the last season. The demand for information regarding it and for seed of it has of late somewhat abated. This crop is gradually winning favor in Florida and in the immediate vicinity of the

Gulf coast as far west as Louisiana. The other crop which, because of judicious advertising, aroused a genuine furore among the farmers of the country, is the so-called pencillaria, well known for many years under the name of "pearl millet." It has been tried during the past season in every State in the Union. Reports from those who have grown it differ widely in their estimate of its value. It undoubtedly has some value as a green feed for the dry period of summer when pastures are short. The principal difficulty with its cultivation seems to be that of securing good seed.

In the live-stock sections of the country there is a growing tendency to utilize cornstalks as stock feed. Much more corn than formerly is cut for fodder and either preserved in the silo or shredded and handled as hay. This practice is adding much to the forage resources of the corn-producing States. In the Southern States, particularly those sections in which the cotton-boll weevil has greatly reduced the profit from cotton culture, much attention is being given to the subject of forage plants. The much-despised Johnson grass is coming into favor again, and a large number of farmers are even sowing seed of this grass. Bermuda grass, which has heretofore been regarded with suspicion by the Southern farmers because of the fact that it is rather difficult of eradication, is receiving much attention as a pasture grass. The area devoted to cowpeas in the Southern States has been greatly enlarged during the past season. A correspondent in northern Alabama states that three times as many peas were sown in his section this year as in any previous year.

As knowledge of the varieties of the cowpea increases this crop is regarded with increasing favor in the Northern States. It has been shown that in the Central States cowpeas will produce a very good crop on land that is so wornout that clover will not grow upon it.

The hairy vetch is growing in popularity as a winter crop for the South. As the seed of this crop is all imported from Europe, and as the United States General Board of Appraisers have so classified it as to require a duty of 30 per cent ad valorem to be paid upon it, there has been considerable difficulty in securing seed at a price that would permit the farmer to sow the crop. It is believed that upon proper representations the seed will be reclassified at an early date, thus greatly reducing the price of it to the farmer. If this is done a great extension of the cultivation of the hairy vetch may be expected next season.

The movement toward live-stock farming and the cultivation of forage crops in the great wheat-growing region of the Pacific Northwest which began about a year ago is even more marked this year than it was last. Thousands of acres of land which heretofore had grown nothing but wheat have been seeded to grass within the past year. As stated last year, the principal grasses used are brome grass for pasture and alfalfa for hay, though tall meadow-oat grass, tall fescue, and orchard grass receive some attention; also timothy and red clover in those parts of the wheat belt where the rainfall is 25 inches or more.

There has been some disappointment in the case of the Turkestan alfalfa seed distributed by the Department some years ago. While the plants raised from this seed have shown points of superiority over the common alfalfa, there is yet no case reported in which a full crop of seed has been produced. Whether this difficulty is due to the particular character of the seasons or to the fact that the plant was not acclimated remains yet to be determined.

PROGRESS OF FORESTRY IN 1902.

By EDWARD A. BRANIFF, *Assistant Editor, Bureau of Forestry.*

The amount and value of the forestry work accomplished in any previous year in this country have been exceeded in 1902, and its national importance has never been so generally recognized as now.

The Bureau of Forestry, with the increased appropriation of last year, has extended its usefulness into new lines of activity, has taken up fresh tasks and completed old ones, and has realized the more keenly as its work has grown the possibilities of accomplishment and the restrictions imposed by insufficient means and an inadequate supply of trained foresters.

Private landowners continue to ask help from the Bureau in putting their forests under management, and the Bureau has not men or money enough to satisfy all the requests.

Progress in forestry is shown conspicuously among the States, and in the Hawaiian and the Philippine Islands. The energy shown by State forest commissions; the growth in attendance at the three professional forest schools; and the establishing of lecture courses in forestry in forty-five State institutions; Hawaii's interest in forestry, displayed by the recent setting aside in the islands of eight forest reserves, the inves-

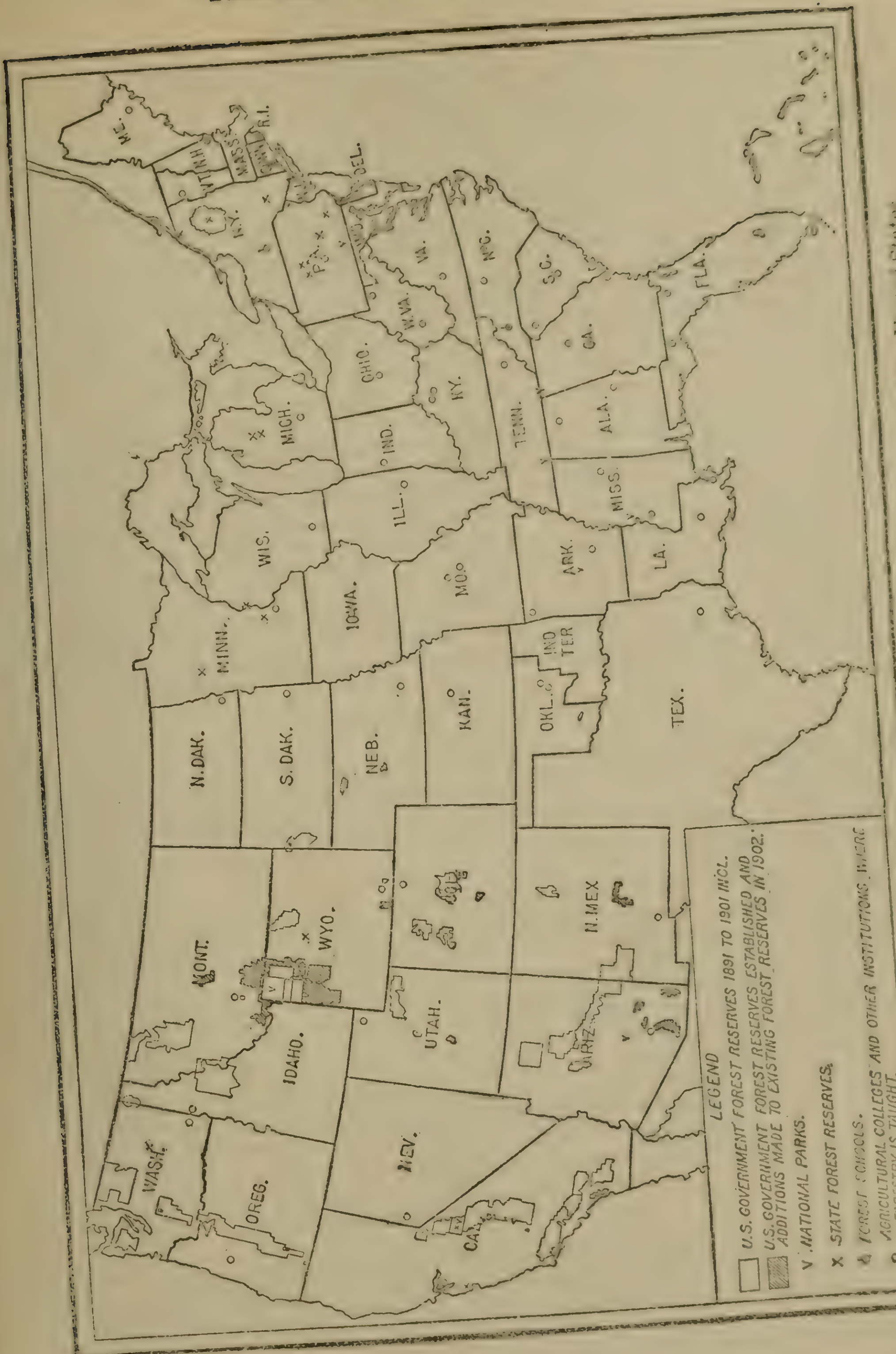

Fig. 61.—Location of forest reserves, national parks, and forestry schools in the United States.

tigations and discoveries of the excellent forestry bureau of the Philippines, all indicate a general and profound belief in the wisdom of a conservative forest policy.

A most important improvement in the method of tapping Southern pines for turpentine and rosin has been made by the Bureau of Forestry. Dr. Charles H. Herty, working under the Bureau's direction at Ocilla, Ga., has discovered a new method of tapping turpentine pines, which he calls the cup-and-gutter system. By this system the tree has been made to yield an increase of 23 per cent of turpentine, and a higher grade of rosin has been secured. Turpentine owners throughout the South have eagerly seized upon the results of the discovery, and many of them have already, with Dr. Herty's personal assistance, installed the cup-and-gutter system in their turpentine orchards.

Extensive tests in timber seasoning and preservation, made by Dr. Hermann von Schrenk in cooperation with the Bureau of Plant Industry, proved of great interest to railroad and mining companies, who did everything possible to aid in the work.

STATE FORESTRY.

Considerable land has been added to the State forests of Pennsylvania. The Forest, Fish, and Game Commission of New York has undertaken to put the State reserve under forest cover. The Massachusetts Forestry Association, the Society for the Protection of New Hampshire Forests, and the Iowa Park and Forest Association have awakened public interest and done effective work in their respective States. The California Water and Forest Association has made advances in its efforts to solve the problems of forestry and water supply in the State. A forestry association has been formed recently in Wyoming. The Minnesota State forestry board has continued its work of putting the State's cut-over lands under forest. The Indiana forest commission recently recommended that the State purchase land for a forest reserve.

ADDITIONS TO NATIONAL RESERVES.

Twelve new national forest reserves (fig. 61) were declared by President Roosevelt during the year; and these, together with additions to reserves already declared, make the total area added during the year, 14,276,476 acres. The total area of all the national forest reserves is now 60,162,525 acres. The new reserves added during the year are as follows:

	Acres.
The San Isabel, Colorado	77,980
The Santa Rita, Arizona	337,300
The Niobrara, Nebraska	123,779
The Dismal River, Nebraska	85,123
The Santa Catalina, Arizona	155,520
The Mount Graham, Arizona	118,600
The Lincoln, New Mexico	500,000
The Chiricahua, Arizona	169,600
The Madison, Montana	736,000
The Little Belt Mountains, Montana	501,000
Alexander Archipelago, Alaska	4,506,240
The Absaroka, Montana	1,311,600

STUDY OF FORESTRY.

The New York State College of Forestry, the Yale Forest School, and the Biltmore Forest School have had more students than ever before. The University of Michigan, the Michigan Agricultural College, and the University of Nebraska have begun instruction in forestry. Courses in forestry, more or less complete, are given in forty-five other institutions.

FOREST FIRES.

Forest fires were unusually destructive during the past year. A special study of fires in Oregon and Washington by the Bureau of Forestry showed that in one week of last September fully $12,000,000 worth of farm property was destroyed, while many persons lost their lives. Serious forest fires burned in twenty-two States. Colorado, Wyoming, and Montana suffered especially. The record of losses from forest fires proves that few States have recently made any considerable advance in checking this great danger.

FORESTRY IN THE HAWAIIAN AND THE PHILIPPINE ISLANDS.

On the island of Hawaii five scattered reserves, with a total of 226,478 acres, and on the island of Maui three reserves, containing 33,379 acres, were set aside. Great interest is shown in forestry in the islands, due to the enormous damage done the forests by grazing of cattle and deer.

The Philippine forests continue to surprise investigators by the variety of their species and the abundance of the valuable timbers which they contain. During the year the forestry bureau at Manila has named and classified many species hitherto unknown, and has made progress in silvicultural studies. The chief of the Bureau of Forestry, United States Department of Agriculture, made a personal study of the forest resources of the Philippines at the request of the Secretary of Agriculture and the Secretary of War. The results of this study will soon be published.

AREAS SURVEYED AND MAPPED BY THE BUREAU OF SOILS.

The following statement shows the areas of which soil surveys have been made up to December 31, 1902. Lithograph maps drawn on a scale of 1 mile to the inch, covering each area surveyed, indicate in colors the location and extent of the various soil types. The accompanying sketch map (fig. 62) indicates the location of these areas.

FIG. 62.—Location of soil surveys mapped by Bureau of Soils.

The statement here shown first gives the area surveyed for each minor division and then the total for the State or Territory.

Areas of soil surveys in the United States to December 31, 1902.

	Square miles.	
Alabama:		
Perry County		762
Arizona:		
Tempe sheet	163	
Phoenix sheet	243	
Buckeye sheet	43	
Yuma area	99	
		548
Arkansas:		
Stuttgart area		251
California:		
Fresno sheet	628	
Hanford sheet	216	
Imperial area	981	
Salinas sheet	189	
California—Continued.		
San Gabriel sheet	259	
Santa Ana sheet	275	
Soledad sheet	155	
Ventura sheet	240	
		2,943
Colorado:		
Arkansas Valley area		945
Connecticut:		
Hartford sheet		245
Florida:		
Gadsden County area		548
Georgia:		
Cobb County area	346	
Covington sheet	225	
		571

Area of soil surveys in the United States to December 31, 1902—Continued.

	Square miles.	
Idaho:		
Boise sheet	155	
Caldwell sheet	244	
Lewiston area	308	
		707
Illinois:		
Clay County	460	
Clinton County	491	
St. Clair County	650	
Tazewell County	645	
		2,246
Indiana:		
Posey County		387
Iowa:		
Dubuque area		440
Kansas:		
Wichita area		465
Kentucky:		
Union County		361
Louisiana:		
Lake Charles area		202
Maryland:		
Calvert County	217	
Cecil County	376	
Harford County	418	
Kent County	293	
Prince George County	480	
St. Mary County	363	
		2,147
Massachusetts:		
Hartford sheet		143
Michigan:		
Allegan County		828
Mississippi:		
Yazoo area	463	
Mayersville sheet	193	
Smedes area	463	
		1,119
Missouri:		
Howell County		919
Montana:		
Billings area		107
New Jersey:		
Salem area	493	
Trenton area	810	
		1,303
New Mexico:		
Carlsbad sheet	80	
Roswell sheet	49	
		129
New York:		
Bigflats area	223	
Lyons area	515	
Westfield sheet	261	
		999
North Carolina:		
Alamance County	365	
Cary sheet	63	
Clayton area	214	
Hickory area	988	
Kingston sheet	257	
Mt. Mitchell sheet	497	
Newbern area	247	
Parmele area	236	
Princeton area	248	
Statesville sheet	784	
Craven area	696	
		4,595
North Dakota:		
Grand Forks area		314
Ohio:		
Columbus area	472	
Montgomery County	480	
Toledo area	403	
		1,355
Pennsylvania:		
Lancaster sheet	269	
Lebanon sheet	669	
		938
Porto Rico:		
Aricebo to Ponce		330
South Carolina:		
Abbeville area	1,006	
Darlington County sheet	599	
		1,605
Tennessee:		
Clarksville area		547
Texas:		
Brazoria area	845	
Vernon area	277	
Willis sheet	215	
		1,337
Utah:		
Salt Lake sheet	249	
Sevier Valley	235	
Weber County	310	
		794
Virginia:		
Albemarle area	1,410	
Bedford sheet	632	
Prince Edward County	430	
		2,472
Washington:		
Sunnyside sheet	224	
Walla Walla area	201	
Yakima sheet	85	
		510
Wisconsin:		
Janesville area		451
Total		34,563

THE PRINCIPAL INJURIOUS INSECTS IN 1902.

By F. H. Chittenden, *Entomologist in Charge of Breeding Experiments.*

The season of 1902 was even more remarkable as regards insect injury than that of 1901, when losses occasioned by insects were noticeably less than in many previous years. This is in treating of the country at large and does not take into consideration certain regions where some pests occurred in their usual numbers or in abnormal abundance. The reason for this diminution in insect injuries in the Atlantic region and a portion of the Middle West is obviously on account of a recurrence of atmospheric conditions prevalent during 1901, which may be characterized as unusually rainy and damp as well as cool at critical periods and places, and a moderately warm winter. Although the insect pests of staple crops, of cereals, of orchards, of vegetables, and of most other forms of vegetation were, as a rule, less troublesome, nearly the usual number of complaints of insect injury were made to the Department of Agriculture and to offices of many State experiment stations. Few new pests of importance developed during the season. The Hessian fly and the Southern grain louse (*Toxoptera graminum* Rond.), which were so very troublesome during the previous year, occasioned very little damage during the season, the second species mentioned, in fact, doing no injury, as far as reported. Several important pests, notably the chinch bug, army worm, bill bugs, pea weevil, striped and twelve-spotted cucumber beetles, and cabbage worms, did much less damage than in many previous years. Such common orchard pests as different

species of scale insects or bark-lice, the codling moth, and the plum curculio were not noticeably troublesome; and the same is true of the commoner shade-tree defoliators—the fall webworm and tussock moth—wireworms, white grubs, and many other forms which were under the average as far as abundance is concerned. Of insect enemies of truck crops other than those that have been mentioned, few complaints were made of the harlequin cabbage bug and tomato worms, while the pea louse did practically no damage.

Among very destructive forms were several species of blister beetles, the cabbage and onion maggots, cherry fruit fly, grasshoppers or locusts of several species, melon louse, rose-chafer, squash-vine borer, squash bug, stalk borer, strawberry weevil, and wheat-head army worm. The larger and smaller corn stalk-borers both increased to a very noticeable extent during the season, especially northward, and, if conditions continue, may become important pests in future years. Among insects injurious to stored products the cigarette beetle has continued, as in the last year or two, in destructiveness, as has also the Mediterranean flour moth, which is gradually increasing its range, and the Angoumois grain moth, which is very troublesome in Pennsylvania and neighboring States.

Of species new as pests that have been prominent during the season are the tobacco-stalk weevil in Texas, and the nun moth, a European insect, which has apparently been introduced in the vicinity of New York City.

AMBROSIA BEETLES.—The common shot-hole borer (*Xyleborus dispar* Fab.) made its first known appearance in the Pacific region in Oregon and Washington. A related form, *X. saxeseni* Ratz., did considerable injury to peach limbs in Connecticut. Other species of this genus were troublesome in Florida and Tennessee.

THE ANGOUMOIS GRAIN MOTH (*Sitotroga cerealella* Zell.) made what is believed to be its first destructive appearance in Michigan during the year.

THE APPLE PLANT-LOUSE (*Aphis mali* et al.).—This pest did considerable damage to orchard trees in Indiana, Illinois, Ohio, Pennsylvania, New Jersey, Rhode Island, Tennessee, Maryland, and Oregon.

APPLE-TREE BORER, FLAT-HEADED (*Chrysobothris femorata* Fab.).—Although perhaps less troublesome than usual to orchard trees, it attracted attention by injury to pecans in Alabama. A similar species, the California big-headed borer (*Chrysobothris mali* Horn), was reported by Professor Cockerell as destructive to the apple in Arizona.

ASPARAGUS MINER (*Agromyza simplex* Loew).—This insect, which has been more or less abundant on asparagus since 1896, was injurious in the District of Columbia.

BARK-BEETLES.—Extensive survey of the principal forest regions of the United States has been continued during the year. (See p. 265 *et seq.*) Coniferous forests have suffered most, and the species attracting the greatest attention through their ravages are the spruce beetle (*Dendroctonus piceaperda* Hopk.), which has destroyed many millions of dollars worth of spruce timber; the destructive pine bark beetle (*D. frontalis* Zimm.), which killed many millions of pine and spruce trees in Virginia and West Virginia about ten years ago, and the pine-destroying beetle of the Black Hills (*D. ponderosæ* Hopk.). The last species has destroyed about 600,000,000 feet of timber in the Black Hills Forest Reserve in South Dakota.

BIRCH SKELETONIZER (*Bucculatrix canadensisella* Chamb.).—This insect was unusually numerous in northern New York and New England.

BLACK GOOSEBERRY BORER (*Xylocrius agassizii* Lec.).—This borer, which first became known as a pest in 1898, was observed on the currant in Washington, a State from which it does not appear to have been previously reported.

BLISTER BEETLES.—Several species were unusually numerous, undoubtedly as a result of the continued outbreaks of locusts or grasshoppers in the regions infested. The two-spotted blister beetle (*Macrobasis albida* Say) was destructive to sugar beets as well as various garden vegetables in the Indian Territory. The ash-gray blister beetle (*M. unicolor* Kby.) was widely injurious from New Hampshire and New York southward to Virginia and westward to Minnesota and Colorado. Nuttall's blister beetle (*Cantharis nuttalli* Say) was injurious in July in North Dakota to oats and barley. The Texas plum blister beetle (*Pomphopœa texana* Lec.) was destructive to the plum in Texas; the peach blister beetle (*P. unguicularis* Lec.) to peach trees and roses in North Carolina, and the pear-tree blister beetle (*P. ænea* Say) to pear blossoms in Pennsylvania. Several other species did local damage.

BOLL WORM OR CORN-EAR WORM (*Heliothis armiger* Hbn.).—This pest increased in destructiveness, being more troublesome than in 1901. The region worst affected extended from West Virginia, Tennessee, and Missouri to Florida and Texas, and injury was reported in Utah. It was estimated that the damage committed by this species in 1901 to the cotton crop of Texas alone reached a sum of nearly $5,000,000, and as injury during the past calendar year was very similar, we might state in round numbers that that was the total damage sustained in Texas.

Brown-tail moth (*Euproctis chrysorrhœa* Linn.).—This has been the occasion of much complaint and of newspaper notoriety in Boston and in neighboring towns, where it has recently been introduced from Europe, with the result that enactments and appropriations have been made by different city governments to combat this shade-tree pest in several localities. In some cases the services of school children have been enlisted by the paying of premiums for the collection of the moths.

Bud moth (*Tmetocera ocellana* Schiff.).—This moth was reported as a bad pest in New York State, injury extending into the maritime provinces of Canada.

Buffalo carpet moth (*Anthrenus scrophulariæ* Linn.).—The beetle known under this name has spread southward during the year, and has been observed in considerable numbers in Washington, D. C., and vicinity, where it was not previously known. Its occurrence has also been noted in New Mexico.

Cabbage fly, European (*Pegomya* [*Phorbia*] *brassicæ* Bouché), was one of the most important of injurious insects in central New York.

Cabbage butterfly, Southern (*Pieris protodice* Boisd.).—After an apparent disappearance for a great many years, owing to the introduction and extensive spread of the imported cabbage butterfly, this pest is returning to its old and native haunts. It was concerned in injury in the District of Columbia and in Arkansas and Georgia. In both cases the individuals kept under observation produced numerous tachina-fly parasites (*Frontina archippivora* Will.), which may be one of the principal agencies which have held this insect in check.

Carrot beetle (*Ligyrus gibbosus* Dej.).—Complained of as an enemy to corn in Minnesota and to ornamental plants in Pennsylvania.

Carrot rust fly (*Psila rosæ* Linn.).—Continued destructive work in New York State, where it was first reported as injuring celery in 1901.

Catalpa sphinx (*Ceratomia catalpæ* Bdv.).—Reported by Professor Webster and others as doing considerable injury to the catalpa in various portions of Ohio and Indiana.

Chain-spotted geometer (*Caterva catenaria* Dr.).—This periodically injurious caterpillar was reported destructive to the lower limbs of the concolor fir in Maine. It also defoliated walnut, poplar, aster, marigold, nasturtium, woodbine, and rose.

Cherry fruit fly (*Rhagoletis cingulata* Loew).—A comparatively new pest, which has been quite injurious to cherries in New York since 1899, has continued its injuries in that State, and during the past two years has been troublesome also in the District of Columbia. As the species is known to inhabit intervening States, there is little doubt that this territory has also been affected, and that the insect is increasing in destructiveness.

Cherry or Forbes's scale (*Aspidiotus forbesi* Johns.).—During the calendar year this species has been reported to the Department of Agriculture from a number of new localities, showing that it is rather rapidly widening its present known range. Its injuries in the more southern States have been quite noticeable.

Chinch bug (*Blissus leucopterus* Say).—Less troublesome than in earlier years owing to the damp weather, which prevailed in its region of greatest destructiveness. It was, however, complained of in Ohio and Wisconsin, and in Minnesota was secondary as a pest only to the Hessian fly.

Cigarette beetle (*Lasioderma serricorne* Fab.).—This insect, which was so destructive to tobacco in store during 1901, was about equally injurious during the past year, more particularly in New York, Virginia, District of Columbia, Ohio, and Indiana. In the last-mentioned State it is known in some portions as "the tobacco flea," a name which it shares with *Epitrix parvula*, which is sometimes taken indoors on tobacco leaves. It also did damage to plush upholstering.

Clover leaf weevil (*Phytonomus punctatus* Fab.).—Rather more abundant than usual over Rhode Island and Ohio and near the District of Columbia, where the second generation was quite commonly found on clover.

Codling moth (*Carpocapsa pomonella* Zell.).—Considerably less destructive the present year than in 1901. Forty-three million bushels of apples was the estimated crop for this season as compared with a product of 25,000,000 bushels the previous year, the difference being very largely attributed to the comparatively small numbers of the codling moth or apple worm.

Colorado potato beetle (*Doryphora decemlineata* Say).—Reported as being most destructive in Indian Territory, eating every species of weed in its path. At Columbia, Miss., it was stated to be useless to plant potatoes on account of its ravages. Two generations were noted there. Near Charleston, S. C., it appeared to be leaving for other quarters. Injuries were reported also in Georgia, and at Burlington, Vt., and some correspondence was had on the occurrence of the species at Wye, Kent, England.

Corn root-worm, Southern (*Diabrotica 12-punctata* Ol.).—Less complained of than in former years, but was noticed in its usual abundance in and near the District of Columbia, in Virginia and Maryland, and in Texas and Arkansas.

Corn stalk-borer, larger (*Diatræa saccharalis* Fab.).—There is evidence that this insect is rather rapidly regaining lost territory in the North in very recent years, having been reported in 1902 as occasioning considerable injury in Virginia, in some portions of which it is known as the "shatter worm." An extensive account of this insect was issued by the Louisiana Experiment Station during the year.

Corn stalk-borer, smaller (*Elasmopalpus lignosellus* Zell.).—This insect which, after an absence of eighteen years became prominent as a pest in the Gulf region in 1899, was destructive to cowpea, bean, and soy bean during 1902 in Virginia, the most northern point at which it has occurred destructively, and in Alabama and Texas, indicating the probability of injury throughout the intervening States.

Corn webworm, sooty (*Crambus caliginosellus* Clem.).—Continues to be one of the worst enemies of young corn in Delaware.

Cotton boll weevil (*Anthonomus grandis* Boh.).—This pest is spreading northward at the estimated rate of 40 to 60 miles each year. In Texas it is reported to have destroyed 400,000 bales of cotton in 1902, a loss estimated by some persons as amounting to as high as $25,000,000. Mr. W. D. Hunter's estimate is $10,000,000.

Cranberry scale (*Aspidiotus ancylus* Putn.).—Destructive over a considerable area during the year from New York to Alabama, Georgia, and Texas, and in Colorado and the State of Washington.

Crickets (*Gryllus abbreviatus* Serv. and *Miogryllus saussurei* Scud.).—These were reported as being dreaded foes of gardens in portions of Louisiana. In one locality they were so troublesome that chickens turned into gardens failed to appreciably reduce their numbers, and farmers were much disheartened by their ravages. Mole crickets, *Scapteriscus abbreviatus* Scudd. and *S. didactylus* Latr., were also destructive in gardens in the South, the former in Florida, the latter in Georgia and Porto Rico. The last is the most important agricultural pest of Porto Rico, and was studied during the year at the agricultural experiment station of that island.

Currant worm, imported (*Pteronus ribesii* Scop.).—Was very destructive in central New York.

Cutworms.—Numerous requests were received for remedies for cutworms, but few instances of serious attack came to notice. *Chorizagrotis agrestis* Grt. was reported in vast multitudes in portions of Nebraska, accompanied by a related species, *Ch. introferens* Gra. *Porosagrotis murænula* G. & R. was destructive during the past three years at Southern Pines, N. C., that locality apparently being literally alive with them. They affected beans, cabbage, cowpea, turnip, melon, and corn, besides the buds and leaves of fruit trees. This species does not appear to have been hitherto regarded as being especially dangerous.

Elm leaf-beetle (*Galerucella luteola* Müll.).—Has reached Saratoga, N. Y., the northernmost locality where it has been seriously injurious. In the District of Columbia and vicinity the insect has almost entirely disappeared.

European orchard scale (*Aspidiotus ostreæformis* Curt.).—Has continued to be most destructive in New York. A report was received of its occurrence in Hobart, Tasmania, showing that it is becoming established as a cosmopolitan pest.

Fall army worm (*Laphygma frugiperda* S. & A.).—Uprisings of this species were reported in South Carolina and Georgia and in Texas. In the last-mentioned State injury to pasture land was noted in several localities. Near Sinton 40,000 acres were stated to have been entirely ruined. Other reports of "army worm" injury in the South were doubtless largely due to the presence of this species.

False chinch bug, minute (*Nysius minutus* Uhl.).—Has continued its destructive work on beets in Colorado, but by planting mustard as a trap crop one of our correspondents succeeded in saving a large portion of his young seed beets. Another saved table beets grown for seed by flooding the fields.

Flea-beetles.—The black flea-beetle (*Systena hudsonias* Forst.) was destructive to corn in Maryland; the cucumber flea-beetle (*Epitrix cucumeris* Harr.) to potato and tomato in Maryland, and the cabbage flea-beetle, striped (*Phyllotreta vittata* Fab.), was exceedingly abundant in the District of Columbia on cruciferous plants of all sorts; also at near-by points of Virginia.

Fruit-tree bark-beetle (*Scolytus rugulosus* Ratz.).—Merely held its own as an established orchard pest. Its reported occurrence in Canada and its increase in the peach-growing districts of central Arkansas are worthy of remark.

Grapevine leaf-hoppers (*Typhlocyba vitifex et al.*).—Were severely injurious in New York, New Jersey, Arkansas, Ohio, and Colorado.

Grapevine root-worm (*Fidia viticida* Walsh).—This insect which has in recent years caused enormous damage in the Ohio grape belt and the Chautauqua grape

district of New York has been the subject of special study during 1902 by official entomologists of that State.

Grasshoppers or locusts (*Acridiidæ*).—These did considerable injury in the northwestern States, more particularly in Minnesota and vicinity. More or less serious outbreaks, however, were noted in Maryland and Virginia, in Ohio, and in California and Texas, and to a variety of grain and forage crops as well as to vegetables. The species doing the greatest amount of damage in Minnesota and neighboring States were the Rocky Mountain locust, lesser migratory, and two-striped locusts. The last mentioned was also quite abundant in Maryland as well as in Canada, while in Ohio the differential locust and in California the devastating locust were important species. American locust (*Schistocerca americana* Dr.) appeared in the vicinity of Roanoke, Va., the irruption extending over 7,000 or 8,000 acres and resulting in the destruction of much corn and clover, was reported, this invasion being a repetition of one which occurred there in 1894. *Melanoplus femoratus* Burm. was so abundant in Virginia as to quite destroy pasture lands and injure hay and grain crops.

Harlequin cabbage bug (*Murgantia histrionica* Hahn.—This cruciferous crop pest, second to none in the South, has nearly disappeared in recent years in its more northern range. Occasionally it crops up locally in Maryland, Virginia, and a little westward, but at the present time is of very little consequence northward. During the year, besides the usual complaints in the South, we received notice of its injuries in the more southern portion of Virginia and at Asbury, Ohio.

Hessian fly (*Cecidomyia destructor* Say).—This notorious grain pest, which was so destructive over large areas during 1901, was quite conspicuous by its absence in localities in which it had formerly been troublesome. Injuries, however, were reported in portions of the States of Minnesota, North Dakota, Missouri, Kansas, and Nebraska.

Horn fly (*Hæmatobia serrata* Desv.).—Has proved a serious annoyance to domestic animals in Ohio and Minnesota.

Imbricated snout-beetle (*Epicærus imbricatus* Say).—Continues to be destructive year by year. During the present season injurious occurrences were reported in Virginia, Missouri, Alabama, and Texas. The damage was more pronounced on fruit trees, but potatoes were also attacked.

Leaf-mining locust beetle (*Odontata dorsalis* Thunb.).—After an apparent absence of a few years from Maryland, Virginia, and the District of Columbia, and perhaps other regions, this beetle returned and did some injury in the defoliation of black and yellow locust. A somewhat exhaustive account of this and related species was completed and published during the year.

Leaf-rollers.—Conspicuously absent, at least as far as reports are concerned. The oblique-banded leaf-roller (*Cacœcia rosaceana* Harr.), did some injury in Maine.

Lima-bean vine-borer (*Monoptilota nubilella* Hulst).—Did damage to Lima beans in the vicinity of Raleigh, N. C., by boring into the stems and forming galls.

Leaf-hopper (*Eutettix tenella* Baker).—Reported as injurious to sugar beet in Arizona.

Mediterranean flour moth (*Ephestia kuehniella* Zell.).—Although, as last year's reports show, this insect is rapidly spreading and increasing as a pest in milling establishments in our principal wheat-growing States, few complaints were made during the year. One of them, however, from Detroit, Mich., is worthy of mention.

Melon louse (*Aphis gossypii* Glov.).—This pest has been extremely destructive during the year. In fact, injury was reported from twice as many localities as in 1901, when it was also quite injurious. The infested area was from New York and Massachusetts southward to the Gulf States and Mexico, and westward in Minnesota and Oregon. This comprises portions of thirteen States besides the District of Columbia and Mexico. Injury was quite severe in Iowa, Arkansas, Texas, Kansas, and Nebraska. Large acreages of cantaloupe and watermelon, and in some cases cucumber and cotton, were infested, and many crops were entirely ruined. In Texas, particularly, very severe injury was sustained. In the region about Waterloo, Nebr., $150,000 was lost on cucumber alone. As usual, much damage attributed to heat and drought was due to this insect.

New York weevil (*Ithycerus noveboracensis* Forst.).—This is, as a rule, only periodically troublesome, was injurious locally in Maryland and Minnesota, attacking opening buds of plum and apple in the spring and early summer.

Nun moth (*Psilura monacha* Linn.).—This destructive European forest pest was reported for the first time in this country in the vicinity of Brooklyn, N. Y. As the specimens captured occurred in the neighborhood of lumber yards where shipping is carried on, it is not certain whether the insect has really found a foothold here, or whether these were accidental captures of individuals which had emerged from wood imported from Europe.

OAK PRUNER (*Elaphidion villosum* Fab.).—The hickory twig-girdler (*Oncideres cingulata* Say) and the Texas twig-girdler (*O. texana* Hom.) were reported during the year as injuring pecan in the South, more especially in Alabama and South Carolina.

ONION MAGGOT, IMPORTED (*Pegomya cepetorum* Meade [*Phorbia ceparum* Meig.].—Injurious to cabbage in Connecticut.

OX WARBLE (*Hypoderma lineata* Vill.).—Appeared in large numbers and proved a great torment to cattle during the year in Mississippi. Complaints were also received from South Dakota, and it seems probable that the injury might have been due to the insect more extensive than reports alone would indicate.

PARSLEY STALK-WEEVIL (*Listronotus latiusculus* Boh.).—This insect was discovered by Mr. F. C. Pratt injuring parsley in Virginia.

PEACH AND PLUM SCALE (*Lecanium nigrofasciatum* Perg.).—About as destructive during the year as in 1901, having been reported from New York and Pennsylvania southward to South Carolina and Louisiana.

PEACH SCALE, NEW (*Aulacaspis* [*Diaspis*] *pentagona* Targ.).—Continued its increase in the District of Columbia and vicinity, but does not appear to have spread to any noticeable extent.

PECAN BUDWORMS, ETC.—Three species of Phycitid moths, *Acrobasis rubrifasciella* Pack., *A. angusella* Grt., and *A. palliolella* Rag., were identified with injury to the buds of pecan in different localities in Georgia during the year.

PERIODICAL CICADA OR SEVENTEEN-YEAR LOCUST (*Cicada septendecim* Linn.).—The year 1902 was what is termed a "cicada year," this insect being very abundant in the entire territory over which its appearance was expected. The infested area has been somewhat extended, notably in Missouri.

PLUM CURCULIO (*Conotrachelus nenuphar* Hbst.).—Reported as injurious in Pennsylvania, Ohio, Indiana, Delaware, Virginia, and Texas. The species is increasing as an apple pest.

POTATO STALK WEEVIL (*Trichobaris trinotata* Say).—Was found to be injuring the stalks of eggplant in Virginia, near the District of Columbia. Some newspaper accounts of injuries to potato in New York can, without much doubt, be referred to this species, as it appears to be extending its range northward.

QUINCE CURCULIO (*Conotrachelus cratægi* Walsh).—Very destructive to the fruit of quince on Long Island.

RASPBERRY GOUTY-GALL BEETLE, OR RED-NECKED RASPBERRY CANE BORER (*Agrilus ruficollis* Fab.).—Injurious in West Virginia.

ROSE-CHAFER (*Macrodactylus subspinosus* Fab.).—The past year was one of rather unusual severity as regards attack by the rose-chafer. Injuries comprised territory from Massachusetts to Maryland and Virginia and westward to Michigan. Considerable destruction to grape, rose, blackberry, and similar plants was quite noticeable in Pennsylvania and on Long Island.

ROSE CURCULIO (*Rhynchites bicolor* Fab.).—Cause of considerable trouble on cultivated rose and peony in Colorado. It was accompanied by a related species, *R. mexicanus* Gyll.

ROSE LEAF-BEETLE (*Nodonota puncticollis* Say).—Injurious nearly every year in Maryland, between Washington and Baltimore, more particularly to roses. The present year it also occurred on corn in one locality.

ROSE SCALE (*Diaspis rosæ* Sandb.).—Destructive to raspberry and blackberry in New Jersey.

SANDWICH ISLAND SUGAR-CANE BORER (*Sphenophorus obscurus* Boisd.).—Severely injurious in Hawaii, infesting different forms of palms and other tropical crops in addition to cane.

SAN JOSE SCALE (*Aspidiotus perniciosus* Comst.).—There was a marked falling off in the number of complaints in regard to injuries by this species, as was true also in the preceding year; and this is to be expected in the future, since orchardists have become acquainted with the insect, the nature of its ravages, and the methods to be used in combating it. State and experiment-station entomologists have done much work in the line of experimentation with remedies, most recently with the lime, salt, and sulphur wash, and fruit growers therefore refer many complaints of damage to the official entomologists of their States which in former times were reported to the Department of Agriculture. Our divisional records do not show increased distribution in areas not previously infested.

SQUASH-VINE BORER (*Melittia satyriniformis* Hbn.).—Rather unusually troublesome and over a considerable area, more particularly in the States of Massachusetts, Rhode Island, New Jersey, Illinois, Virginia, and Florida. For some reason it did not particularly attract attention in the District of Columbia and the adjacent portions of Maryland and Virginia.

SOUTHERN GRAIN LOUSE (*Toxoptera graminum* Rond.).—This insect, which was so destructive to small grains in Texas during 1901, particularly wheat, seems to have entirely disappeared; at least, no complaints were noted of its injurious occurrence.

SQUASH BUG, COMMON (*Anasa tristis* De G.).—During 1902 Mr. A. J. Pieters called attention to the fact that for several years seedsmen of the United States had been very much troubled by the attacks of this insect; so much so that in 1901, out of a possible 40,000 pounds of seed expected from 400 acres by one dealer, only 1,800 pounds were harvested. This crop was planted in different parts of Michigan, Illinois, Kansas, Nebraska, and Oklahoma, and is only one instance out of many that could be cited. Injuries during 1901 were unusually severe, as already reported, and in 1902 about the same, not alone to squash, but to marrows, melons, cucumbers, pumpkins, etc. Ravages were most pronounced, according to Department records, in Illinois, Indiana, New York, Pennsylvania, and portions of Virginia. Its numbers were compared to swarms of bees. In some localities 90 per cent of cucumbers were destroyed, and some reported that the insect could not be successfully combated.

ST. ANDREW'S COTTON STAINER (*Dysdercus andreæ* Linn.).—Some interesting facts concerning the economy of this species were learned during the year. It is generally distributed in the West Indies, and injures cotton in the same manner as our native cotton stainer, *D. suturellus* H.-S.

STALK BORER (*Hydrœcia nitela* Gn.).—Reported as doing considerable damage in Massachusetts, Pennsylvania, New Jersey, Ohio, and Minnesota, more particularly to tomatoes and corn, but other plants, including currant and various ornamentals, were bored into and injured.

STRAWBERRY ROOT-LOUSE (*Aphis forbesi* Weed).—Prominent as a strawberry enemy in Delaware, where it was given considerable study by Professor Sanderson, looking toward better means for its control.

STRAWBERRY WEEVIL (*Anthonomus signatus* Say).—Unusually injurious the past year, the infested area extending over several States. In New Jersey the crop was estimated to be reduced fully one-half, in Maryland from 25 to 50 per cent, and in Delaware about one-third of early staminate varieties were cut off, while in other instances entire crops were practically ruined. In North Carolina the insect had been noted as destructive in the eastern portion two or three years previously. Injury was noted in Arkansas and Indiana for the first time. In some localities growers had adopted the planting of profuse-blooming varieties, and the result of the weevil attack was, to a certain extent, beneficial, as tending to thin out the fruit, furnishing greater size and better quality.

STRIPED CUCUMBER BEETLE (*Diabrotica vittata* Fab.).—About as injurious as in 1901, report of more or less damage having been received from Pennsylvania, Mississippi, New Jersey, Illinois, Missouri, and Texas. In the last-mentioned State various persons testified that it made its first appearance in Cooke County in destructive numbers that year.

SWEET-POTATO TORTOISE BEETLES (*Coptocycla bicolor*, *Cassida bivittata*, etc.).—Reported as doing more or less damage to sweet potato and morning glory in the States of Georgia, Connecticut, Pennsylvania, Maryland, and Virginia, and in the District of Columbia.

TENT CATERPILLAR, FOREST, OR FOREST ARMY WORM (*Clisiocampa disstria* Hbn.).—Observed in such small numbers in New York that Dr. Felt predicted that possibly this year might see the end of its depredations, which had been very considerable during recent years. This supposition is borne out by Department records, no complaints of injury having been made during the year.

TENT CATERPILLAR, APPLE-TREE (*Clisiocampa americana* Harr.).—Abundant and destructive in Delaware, Maryland, Michigan, Connecticut, Rhode Island, Pennsylvania, and New York.

TOBACCO STALK WEEVIL (*Trichobaris mucorea* Lec.).—One of the most remarkable occurrences of the year was that of this species, previously unknown as injurious. It was extremely destructive in the vicinity of Willis, Tex., destroying whole crops in that region. Although this occurrence appeared to be local, the insect had been destructive, although not recognized, in previous years, and there is a possibility of its becoming a very serious drawback to the tobacco industry in that and perhaps some neighboring States. It is worthy of remark that a related species, *Trichobaris insolita* Cas., has been recognized recently as being concerned in tobacco injury in Florida.

TWO-LINED CHESTNUT BEETLE (*Agrilus bilineatus* Webb).—Injurious to oak in Kenosha County, Wis.

VINE-CHAFERS.—Quite prominent as pests during the last two or three years. In 1902 *Anomala binotata* was injurious to roses in the vicinity of New York, and *A. undulata* was destructive to cherry in Alabama and Tennessee.

VIOLET SAWFLY (*Emphytus canadensis* Kby.).—Reported to be injuring violets at Brighton, Washington State, where it has probably been introduced from the East.

WHEAT-HEAD ARMY WORM (*Leucania albilinea* Guen.).—This periodical pest was reported as doing injury to wheat in Kansas and Nebraska, to timothy in Ohio, and to wild rice grown in Minnesota.

WILLOW OR POPLAR CURCULIO, IMPORTED (*Cryptorhynchus lapathi* Linn.).—This insect continues as a pest in the vicinity of Boston, Mass., and during the year causing injury in western New York and at Providence, R. I.

WILLOW LEAF-BEETLE, SPOTTED (*Melasoma lapponica* Linn.).—Reported to be injuring willow in New York.

WILLOW SLUG, YELLOW-SPOTTED (*Nematus ventralis* Say).—This, one of the worst enemies of osier willow, was also injurious in New York State.

ZEBRA CATERPILLAR (*Mamestra picta* Harr.).—Concerned in injury to osier willow in New York and attracted attention in the District of Columbia by what appears to be a new habit of boring into buds and flowers of roses. It was more seriously injurious to cabbage at Junction, Ohio, than the imported cabbage worm and in New Jersey also did injury to cabbage and cauliflower.

PROGRESS IN GAME PROTECTION IN 1902.

By T. S. PALMER, *of the Biological Survey.*

LEGISLATION.

Two important Federal laws relating to game were passed during the year 1902: (1) An act amending the tariff act so as to permit the importation of the eggs of game birds for propagation, and (2) an act protecting game in Alaska. The Alaska act, which is the first general game law of the Territory, fixes close seasons and prohibits export and sale, though permitting shipment of specimens and trophies for scientific purposes under regulations made by the Secretary of Agriculture. Legislative sessions were held in less than one-third of the States and Territories, but in nearly every case some changes were made in laws for the protection of game. General game laws were enacted by Kentucky, Louisiana, and Ohio. The adoption of nonexport provisions this year in several States reduces the number of States which permit unlimited export of game to three, all in the South. Three States—Kentucky, New Jersey, and Ohio—adopted the license system, by which nonresidents are required to secure licenses to hunt, fixing fees of $10 in New Jersey and $25 each in Kentucky and Ohio. Nonresident licenses at rates ranging from $5 to $40 are now required in half the States and Territories and in nearly all the Provinces of Canada. Arkansas and Oregon, however, require licenses only for market hunting, and New York only from residents of States which demand similar licenses from residents of New York. Louisiana and Missouri do not permit nonresidents to kill game within the State. Additional restrictions on the sale of game were adopted in South Carolina, and a statute allowing dealers to hold their game under bond during the close season was passed in New York.

The movement toward securing uniform laws for the protection of song, insectivorous, and other nongame birds made substantial progress during the year. Alaska, Kentucky, and Ohio extended protection to birds other than game, increasing the number of States which now have a practically uniform law of this kind to 19. A similar law was adopted for the Northwest Territories, Canada, and the legislature of Maryland passed a law of like character for Washington County.

ENFORCEMENT.

New York has raised the number of its game protectors from 38 to 50, and New Jersey has given its wardens additional powers to make searches and seizures. In Oklahoma the Territorial authorities seized several large consignments of game en route to Eastern markets contrary to law, and have taken steps to secure a more stringent enforcement of the nonexport laws. The case of the State of New York against the Arctic Freezing Company, involving the possession and sale of game from other States held in storage during the close season, was carried to the court of appeals. This is one of the most important game cases of recent years, both on account of the large penalties involved and the far-reaching effects of a decision on several of the points at issue.

Under the Lacey Act numerous seizures were made of game shipped from the

West and Southwest, and proceedings were instituted in a number of cases in State and Federal courts. In some of the cases in Iowa and South Dakota convictions were secured with penalties ranging from $150 to $200. The inspection of foreign birds at the port of New York was made more effective, and special inspection service was established in Hawaii and extended in scope so as to prevent the introduction of noxious reptiles into the islands.

GAME COMMISSIONS AND OTHER ORGANIZATIONS.

Even more important than the enactment of new game laws has been the work of game commissions and voluntary organizations interested in the practical protection of birds and game. In 1902 important changes were made in the game commissions of Ohio and Vermont, and a new Territorial warden was appointed in Oklahoma. Several sportsmen's game and fish protective associations were added to the large number already existing, and new Audubon societies were organized in Louisiana, Nebraska, North Carolina, Oklahoma, and Oregon. Thirty-two States now have Audubon societies, which are formed primarily for the protection of birds other than game. The committee of the American Ornithologists' Union on the protection of birds extended its work along the coast, and now maintains supervision of all the breeding colonies of sea birds on the Atlantic coast, from Eastport, Me., to Chesapeake Bay, as well as at some points in Florida.

RESTORATION OF GAME.

Two important experiments were made during the year with a view to restoring game in certain areas. An appropriation of $5,000 was made by the legislature of New York in 1901 to restock the Adirondacks with moose. During the summer of 1902 the Forest, Fish, and Game Commission of the State imported a number of moose from Canada and liberated them in the Adirondack wilderness. By the aid of a special appropriation of $15,000 the Secretary of the Interior purchased a few buffalo to add to the herd in the Yellowstone Park for the purpose of introducing new blood. This was the first direct appropriation ever made by Congress for the preservation of buffalo, and marks the beginning of a new era in the protection of game in the park.

LEGISLATION FOR ROAD IMPROVEMENT IN 1902.

During 1902 there was comparatively little legislation affecting roads, the legislatures being in session in only thirteen States.

In South Carolina and Mississippi general road laws were enacted.

STATE AID.

In California a constitutional amendment was adopted empowering the legislature to establish, construct, and maintain a system of State highways, to declare any road a State road, and to extend aid for construction and maintenance of county roads.

In Minnesota a constitutional amendment providing for State aid in construction of roads and bridges was submitted to the electors, but failed of adoption.

The State-aid law of New York was so amended as to empower the State engineer to repair improved highways in any county and charge the expense to the county in case the proper county authorities fail to make the needed repairs; also, in case of townships which adopt the money system instead of the labor system of repairing the roads, an amendment increases the amount of aid which may be secured from the State from 25 to 50 per cent of the township levy.

In Rhode Island a State board of public roads was created with power to recommend relocating and improving main highways, to regulate the apportionment of State funds, and to control methods of construction. No salaries are paid to members, and the plans and recommendations made by the board are subject to the approval of the legislature.

BORROWING MONEY.

The State Highway Commission of Massachusetts was authorized to expend $500,000 in construction and repair of State highways, and in order to raise this sum the State treasurer was authorized to issue scrip or certificates of indebtedness bearing interest not to exceed 4 per cent.

In Mississippi a law was passed authorizing county boards of supervisors to borrow money for use in improving roads, the interest and principal to be paid by the owners of property benefited.

In New York towns were authorized to borrow money for construction of bridges, subject to ratification by town meeting.

MISCELLANEOUS.

In Iowa the road districts into which townships were divided were abolished and each township was made a single road district.

In Kentucky and New York laws were passed providing for purchase of tools and machinery to be used in road work and authorizing the acquirement of land for gravel pits and stone quarries.

In Ohio, Massachusetts, New York, and Rhode Island laws were passed regulating the speed of bicycles and automobiles and providing penalties.

PROGRESS OF IRRIGATION IN 1902.

By Elwood Mead, *Chief of Irrigation Investigations.*

The taking of water from streams for irrigation has been largely without public control. Such control as has existed has been exercised by the several States and Territories as explained below. Two Departments of the National Government are, however, engaged in investigations and the collection and publication of information which has a direct bearing on the proper control and use of the water supply for irrigation purposes.

NATIONAL IRRIGATION WORKS.

The Department of the Interior, through the Hydrographic Division of the Geological Survey, deals with questions relating to the water supply and the location, construction, and management of irrigation works under an act of Congress approved June 17, 1902. This law provides that the receipts from the disposal of public lands in Arizona, California, Colorado, Idaho, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Utah, Washington, and Wyoming shall be set aside for the construction of irrigation works in the States and Territories named. The work provided for is under the direction of the Secretary of the Interior and has been by him assigned to the United States Geological Survey. The act contemplates the furnishing of water to both public and private lands. The Government is to build the works and sell the water to landowners and homesteaders on the public land for enough to repay the estimated cost of the works. The payments for water are to be made in not more than ten annual installments, the Secretary of the Interior having power to determine when the first payment shall be made. The works are to be maintained and operated at public expense until the payments for the major portion of the lands irrigated by them are made, when they may be turned over to the water users, to be operated at their expense, but they are to remain under public control until otherwise provided by Congress. Before beginning the surveys for contemplated works the Secretary of the Interior is to withdraw from entry, except under the homestead laws, any lands that may be irrigated from such works. Surveys are then made and the practicability of the proposed work determined. If it is decided that a project is impracticable the lands withdrawn are to be restored to the public domain. If it is decided to build the works the Secretary is to give public notice of the lands to be irrigated, the limit of area which may be entered by each person, and the charges which are to be made for supplying water, both to homesteaders and to owners of land under the works. No landowner can purchase water for more than 160 acres. A homesteader is required to reclaim at least one-half his entry, and will not receive patent to the land until the charges assessed against such lands are paid. The Secretary of the Interior is authorized to make all rules necessary to carry out the law. No projects have as yet been decided upon, but several tracts of land have been withdrawn, pending preliminary surveys.

SCOPE OF WORK OF DEPARTMENT OF AGRICULTURE.

The Department of Agriculture, through the irrigation investigations of the Office of Experiment Stations, is studying (1) the laws and institutions of the different States relating to the ownership and distribution of the public water supplies, and

(2) the engineering and agricultural questions connected with the actual use of the water in irrigation. This work of the Department of Agriculture includes a study of the operation of the laws of the several States and Territories as affecting irrigation development; methods of canal management and disposal of water, to find what plan of organization will bring about the best use of water and at the same time secure justice to both investors and settlers; present methods of using water and the quantities actually required under varying conditions of crop, soil, and season in both arid and humid regions, with a view to securing information for use in the adjudication of water rights, in planning irrigation works, and in promoting more economical use of water by irrigators; pumps and pumping, and of various kinds of power used for this purpose; and the engineering questions connected with the draining of land.

STATE CONTROL OF IRRIGATION.

A list of the principal State and Territorial officers charged with supervision and control of irrigation in the arid regions is furnished on page 674. In but three States—Colorado, Nebraska, and Wyoming—is the system of supervision and control at all complete. In several of the States no public control or supervision whatever is exercised, while in others, although the laws have provided schemes of varying efficiency, few officers have been appointed to carry them out. In States where county officers are placed by law in charge of irrigation, difficulty has been encountered in ascertaining if the law has been carried out and officers appointed, but it is believed that the list given is substantially complete.

Arizona.—In this Territory the public acequias or irrigating canals are placed by law under the supervision of overseers to be elected and paid by the people whose lands the acequias water. It is the duty of these overseers to superintend the construction and maintenance of the acequias, and to apportion the water carried by them among those entitled to it. So far as could be ascertained no such overseers hold office at the present time. One water commissioner, whose name is included in the list on page 674, has been appointed by the court at Phoenix to enforce its decrees. This commissioner is an entirely different officer from the overseers provided for as mentioned above. The law of Arizona charges no Territorial officer with duties pertaining to irrigation or irrigation water.

California.—No public authority is exercised over irrigation in California beyond the fixing of rates for irrigation water by county boards of supervisors and town councils. At one time a number of minor officers were appointed in some of the southern counties, but none are known to hold office now. The office of State engineer, whose duty it was to investigate and report on matters pertaining to irrigation, has been abolished.

Colorado.—For the administration and control of irrigation water, this State is divided into water divisions, which are again divided into water districts. Over each water district is a water commissioner, and over each division is a water superintendent. It is the duty of these commissioners and superintendents to apportion the water of streams according to the decrees of the courts which hold jurisdiction over water titles. It is the duty of the State engineer to measure streams and canals and to otherwise investigate the water resources of the State, as well as to ascertain such physical facts concerning irrigation and irrigation water as may be needed by the courts in decreeing titles to irrigation water or by administrative officers in carrying out such decrees. He also exercises general supervision over the division superintendents and the district commissioners. County commissioners have power to fix rates to be charged for the use of water supplied by canal companies.

Idaho.—The laws of Idaho provide for the adjudication of water rights by the district courts. Parties interested may elect a water commissioner to enforce the decree, and in case of their failure to do so the judge of the district court shall, on the petition of ten of the users of water, appoint such commissioner. The boards of county commissioners are by law made water commissioners, with power to fix rates and to make such regulations as may be necessary to secure an equal and fair distribution of water. The State engineer has supervision of operations under the Carey Act and the organization of irrigation districts.

Kansas.—Exclusive jurisdiction of water rights is given to the district courts, which are required to appoint water bailiffs to enforce their decrees. Ditch owners are required to elect superintendents to distribute the water carried by their ditches. The board of railroad commissioners is charged with fixing water rates.

Montana.—Under the law of this State a court which has adjudicated the rights to a stream must, upon the application of the parties holding rights to 25 per cent of the water, appoint a commissioner to enforce the decree. The reclamation of land under the Carey Act was placed in the hands of a commission, of which the president and

secretary still hold office. No other supervision is exercised over irrigation in the State.

Nebraska.—In Nebraska there is a system of public control of irrigation similar to that in force in Wyoming. The State is divided into two water divisions, and there is a State board of irrigation, composed of the governor, the attorney-general, and the commissioner of public lands and buildings, whose duty it is to pass on all claims to water and to adjudicate all water titles, and also, through the State engineer, who is the secretary of the board, to measure streams and canals and investigate the water resources of the State. The board of control elects an undersecretary for each of the two water divisions, who has supervision and control of the distribution of water in his division. The divisions are separated into water districts, which are in charge of underassistants.

Nevada.—A law passed by the legislature of Nevada in 1901 created a State board of irrigation, to consist of the governor, the attorney-general, and the surveyor-general. By a law passed in 1899 the board of county commissioners of each county may constitute itself, together with the county surveyor, a board of water commissioners. Parties wishing to appropriate water must apply to this board and receive a permit before constructing any works. But one county, Washoe, has thus far availed itself of the provisions of the act.

New Mexico.—The laws of this Territory contain practically the same provisions concerning the management of public acequias as do the laws of Arizona, mentioned above. There is also in this Territory an irrigation commission, whose duties are not, however, connected directly with the administration and control of streams.

North Dakota.—Until recently there was a commissioner of irrigation and forestry in North Dakota, but the office was abolished by the legislature of 1901. Parties appropriating water must post and file notices of their intentions.

Oklahoma.—The waters of the Territory are declared to be the property of the public, and rights to their use may be acquired by appropriation. Water may be diverted from streams for irrigation, mining, milling, city supply, and stock raising. Persons diverting water are required to file and cause to be recorded in the office of the recorder of deeds of the county where the works are situated a statement of the size and location of the works and the purpose for which the water is taken. The law does not provide any officials to protect the rights to water, hence anyone whose rights are infringed must go to the courts for redress.

Oregon.—There is no public supervision of irrigation in Oregon, and therefore no officers for such supervision.

South Dakota.—The only public supervision exercised over irrigation in South Dakota is exercised by the State engineer of irrigation, who is appointed by the governor of the State. His duties are not of an administrative nature, but have to do chiefly with the location of artesian wells.

Texas.—Control of irrigation in Texas is left by law in the hands of the commissioners' courts. These courts have not, so far as could be ascertained, appointed any officers to have charge of irrigation matters.

Utah.—In this State the supervision and administration of water is by counties. The legislature of 1901 passed a law empowering the county commissioners of each county to appoint at least one commissioner to apportion the water within their county. Commissioners have been appointed for many of the streams. The State engineer gauges the streams of the State and instructs water commissioners as to the division of water.

Washington.—In this State each county is constituted an irrigation district, and for each district a water commissioner may be appointed by the county commissioners. The duties of the water commissioners are substantially the same as those of such officers in Colorado. In times of scarcity the superior court of any county is charged with the duty, upon application by any interested person, of appointing three commissioners to apportion the water of the streams in which the scarcity exists, in accordance with equitable and vested rights.

Wyoming.—By constitutional provision all of the water within the State of Wyoming is the property of the State. The State is divided into four water divisions, which conform to natural drainage lines, over each of which is a water superintendent. The four division superintendents, with the State engineer, constitute the State board of control, which has supervision of the waters of the State and of their appropriation, distribution, and division. The State engineer is president of the board of control. For the administration of the water supplies within the four divisions these divisions are separated into water districts presided over by water commissioners, whose duties are subordinate to those of the division superintendents.

PUBLICATIONS OF THE DEPARTMENT OF AGRICULTURE.

The publications of the United States Department of Agriculture are mainly of three general classes:

I. Publications issued annually, comprising the yearbooks, the annual reports of the Department, the annual reports of the Bureau of Animal Industry, Weather Bureau, and Bureau of Soils.

II. Other departmental reports, divisional bulletins, etc. Of these, each bureau, division, and office has its separate series, in which the publications are numbered consecutively as issued. They comprise reports and discussions of a scientific or technical character.

III. Farmers' Bulletins, divisional circulars, reprinted Yearbook articles, and other popular papers.

The publications in Class I are distributed by the Department and by Senators and Representatives in Congress. For instance, of the 500,000 copies of the Yearbook usually issued the Department is allotted only 30,000, while the remaining 470,000 copies are distributed by members of Congress. The Department's supply of the publications of this class is therefore limited, and consequently has to be reserved almost exclusively for distribution to its own special correspondents and in return for services rendered.

The publications of Class II are not for distribution by members of Congress, and they are not issued in editions large enough to warrant free general distribution by the Department. The supply is used mainly for distribution to those who cooperate with the Department or render it some service, and to educational and other public institutions. A sample copy of this class of publications can usually be sent on application, but aside from this the Department generally finds it necessary to refer applicants to the Superintendent of Documents, of whom further mention is made below.

The publications of Class III treat in a practical way of subjects of particular interest to farmers. They are usually issued in large editions, and are for free general distribution by the Department. The Farmers' Bulletins are also for distribution by Senators and Representatives in Congress, to each of whom is furnished annually, according to law, a quota of several thousand copies for distribution among his constituents.

A limited supply of nearly all the publications in Classes I and II is, in compliance with the law, placed in the hands of the Superintendent of Documents for sale at cost of printing. Applications for these should be addressed to the Superintendent of Documents, Union Building, Washington, D. C., and should be accompanied by postal money order payable to him for the amount of the price. No postage stamps nor private checks should be sent. The Superintendent of Documents is not permitted to sell more than one copy of any public document to the same person. The Public Printer may sell to one person any number not to exceed 250 copies if ordered before the publication goes to press.

The Secretary of Agriculture has no voice in designating the public libraries which shall be depositories of public documents. Of the distribution of documents to such depositories, including the publications of this and all other Departments of the Government, the Superintendent of Documents has full charge.

For publications of the Weather Bureau requests and remittances should be directed to the Chief of the Weather Bureau.

The Department has no list of persons to whom all publications are sent. A monthly list is issued on the first day of each month giving the titles of all publications issued during the previous month, with all the explanations necessary to enable applicants to order intelligently. This list will be mailed regularly to all who apply for it. The Department also issues and sends out to all who apply for them a complete list of all publications of which the Department has a supply for free distribution, and a similar list of all the Department's publications for sale by the Superintendent of Documents.

FARMERS' BULLETINS.

The following list of Farmers' Bulletins is intended to offer the best practical results of the Department investigations. It is the purpose not to allow any one of them to become exhausted. Reprints are constantly made, so that all are available at all times except when withdrawn to be replaced by a more useful statement of the facts. Numbers omitted were attached to bulletins that were out of date and in most cases have been superseded by others presenting more recent information.

16. Leguminous Plants. Pp. 24.
21. Barnyard Manure. Pp. 32.
22. The Feeding of Farm Animals. Pp. 32.
24. Hog Cholera and Swine Plague. Pp. 16.
25. Peanuts: Culture and Uses. Pp. 24.
27. Flax for Seed and Fiber. Pp. 16.
28. Weeds: And How to Kill Them. Pp. 32.
29. Souring and Other Changes in Milk. Pp. 23.
30. Grape Diseases on the Pacific Coast. Pp. 15.
31. Alfalfa, or Lucern. Pp. 24.
32. Silos and Silage. Pp. 32.
33. Peach Growing for Market. Pp. 24.
34. Meats: Composition and Cooking. Pp. 29.
35. Potato Culture. Pp. 24.
36. Cotton Seed and Its Products. Pp. 16.
37. Kafir Corn: Culture and Uses. Pp. 12.
38. Spraying for Fruit Diseases. Pp. 12.
39. Onion Culture. Pp. 31.
40. Farm Drainage. Pp. 24.
42. Facts About Milk. Pp. 29.
43. Sewage Disposal on the Farm. Pp. 20.
44. Commercial Fertilizers. Pp. 24.
45. Insects Injurious to Stored Grain. Pp. 24.
46. Irrigation in Humid Climates. Pp. 27.
47. Insects Affecting the Cotton Plant. Pp. 32.
48. The Manuring of Cotton. Pp. 16.
49. Sheep Feeding. Pp. 24.
50. Sorghum as a Forage Crop. Pp. 20.
51. Standard Varieties of Chickens. Pp. 48.
52. The Sugar Beet. Pp. 48.
53. How to Grow Mushrooms. Pp. 20.
54. Some Common Birds. Pp. 40.
55. The Dairy Herd. Pp. 24.
56. Experiment Station Work—I. Pp. 31.
57. Butter Making on the Farm. Pp. 16.
58. The Soy Bean as a Forage Crop. Pp. 24.
59. Bee Keeping. Pp. 32.
60. Methods of Curing Tobacco. Pp. 16.
61. Asparagus Culture. Pp. 40.
62. Marketing Farm Produce. Pp. 28.
63. Care of Milk on the Farm. Pp. 40.
64. Ducks and Geese. Pp. 48.
65. Experiment Station Work—II. Pp. 32.
66. Meadows and Pastures. Pp. 28.
68. The Black Rot of the Cabbage. Pp. 22.
69. Experiment Station Work—III. Pp. 32.
70. Insect Enemies of the Grape. Pp. 23.
71. Essentials in Beef Production. Pp. 24.
72. Cattle Ranges of the Southwest. Pp. 32.
73. Experiment Station Work—IV. Pp. 32.
74. Milk as Food. Pp. 39.
75. The Grain Smuts. Pp. 20.
76. Tomato Growing. Pp. 30.
77. The Liming of Soils. Pp. 19.
78. Experiment Station Work—V. Pp. 32.
79. Experiment Station Work—VI. Pp. 28.
80. The Peach Twig-borer. Pp. 16.
81. Corn Culture in the South. Pp. 24.
82. The Culture of Tobacco. Pp. 24.
83. Tobacco Soils. Pp. 23.
84. Experiment Station Work—VII. Pp. 32.
85. Fish as Food. Pp. 30.
86. Thirty Poisonous Plants. Pp. 32.
87. Experiment Station Work—VIII. Pp. 32.
88. Alkali Lands. Pp. 23.
89. Cowpeas. Pp. 16.
91. Potato Diseases and Treatment. Pp. 12.
92. Experiment Station Work—IX. Pp. 30.
93. Sugar as Food. Pp. 27.
94. The Vegetable Garden. Pp. 24.
95. Good Roads for Farmers. Pp. 47.
96. Raising Sheep for Mutton. Pp. 48.
97. Experiment Station Work—X. Pp. 32.
98. Suggestions to Southern Farmers. Pp. 48.
99. Insect Enemies of Shade Trees. Pp. 30.
100. Hog Raising in the South. Pp. 40.
101. Millets. Pp. 28.
102. Southern Forage Plants. Pp. 48.
103. Experiment Station Work—XI. Pp. 32.
104. Notes on Frost. Pp. 24.
105. Experiment Station Work—XII. Pp. 32.
106. Breeds of Dairy Cattle. Pp. 48.
107. Experiment Station Work—XIII. Pp. 32.
108. Saltbushes. Pp. 20.
109. Farmers' Reading Courses. Pp. 20.
110. Rice Culture in the United States. Pp. 28.
111. Farmers' Interest in Good Seed. Pp. 24.
112. Bread and Bread Making. Pp. 39.
113. The Apple and How to Grow It. Pp. 32.
114. Experiment Station Work—XIV. Pp. 28.
115. Hop Culture in California. Pp. 27.
116. Irrigation in Fruit Growing. Pp. 48.
117. Sheep, Hogs, and Horses in the Northwest. Pp. 28.
118. Grape Growing in the South. Pp. 32.
119. Experiment Station Work—XV. Pp. 31.
120. Insects Affecting Tobacco. Pp. 32.
121. Beans, Peas, and other Legumes as Food. Pp. 32.
122. Experiment Station Work—XVI. Pp. 32.
123. Red Clover Seed: Information for Purchasers. Pp. 11.
124. Experiment Station Work—XVII. Pp. 32.
125. Protection of Food Products from Injurious Temperatures. Pp. 26.
126. Practical Suggestions for Farm Buildings. Pp. 48.
127. Important Insecticides. Pp. 42.
128. Eggs and their Uses as Food. Pp. 32.
129. Sweet Potatoes. Pp. 40.
130. The Mexican Cotton Boll Weevil. Pp. 30.
131. Household Tests for Detection of Oleomargarine and Renovated Butter. Pp. 11.
132. Insect Enemies of Growing Wheat. Pp. 40.
133. Experiment Station Work—XVIII. Pp. 32.
134. Tree Planting in Rural School Grounds. Pp. 38.
135. Sorghum Sirup Manufacture. Pp. 40.
136. Earth Roads. Pp. 24.
137. The Angora Goat. Pp. 48.
138. Irrigation in Field and Garden. Pp. 40.
139. Emmer: A Grain for the Semiarid Regions. Pp. 16.
140. Pineapple Growing. Pp. 48.
141. Poultry Raising on the Farm. Pp. 16.
142. The Nutritive and Economic Value of Food. Pp. 48.
143. The Conformation of Beef and Dairy Cattle. Pp. 44.
144. Experiment Station Work—XIX. Pp. 32.
145. Carbon Bisulphid as an Insecticide. Pp. 28.
146. Insecticides and Fungicides. Pp. 16.
147. Winter Forage Crops for the South. Pp. 36.
148. Celery Culture. Pp. 32.
149. Experiment Station Work—XX. Pp. 32.
150. Clearing New Land. Pp. 24.
151. Dairying in the South. Pp. 48.
152. Scabies in Cattle. Pp. 24.
153. Orchard Enemies in the Pacific Northwest. Pp. 39.
154. The Fruit Garden: Preparation and Care. Pp. 20.
155. How Insects Affect Health in Rural Districts. Pp. 20.
156. The Home Vineyard. Pp. 24.
157. The Propagation of Plants. Pp. 24.
158. How to Build Small Irrigation Ditches. Pp. 28.
160. Game Laws for 1902. Pp. 56.
161. Practical Suggestions for Fruit Growers. Pp. 28.
162. Experiment Station Work—XXI.
163. Methods of Controlling the Boll Weevil.
164. Rape as a Forage Crop. Pp. 15.

AGRICULTURAL PERIODICALS IN DEPARTMENT LIBRARY, 1902.

The following is a list of the agricultural periodicals which were regularly received at the Department library during 1902. All are valuable, but no recommendation is intended by the publication of the list. Most are sent free to the Department as a public service, and among those so sent are some of the best. On the other hand, some valuable papers are not sent free, and as their field is covered by something else, a subscription is unnecessary. Consequently they do not appear in the list.

Periodicals published in the United States.

State or Territory.	Name of periodical.	Post-office.
Arizona	Southwestern Stockman and Miner. W.[a]	Tucson.
Arkansas	Poultry Gem. M.[b]	Siloam Springs.
California	Breeder and Sportsman. W	San Francisco.
	California Cultivator. W	Los Angeles.
	California Fruit Grower. W	San Francisco.
	Dairy and Produce Review. W	Do.
	Live Stock Tribune. M	Los Angeles.
	Pacific Coast Fanciers' Monthly. M	San Jose.
	Pacific Coast Fruit World. W	Los Angeles.
	Pacific Rural Press and California Fruit Bulletin. W.	San Francisco.
	Pacific Wine and Spirit Review. M	Do.
	Petaluma Poultry Journal. W	Petaluma.
	Rural Californian. M	Los Angeles.
	Western Creamery. M	San Francisco.
Colorado	Denver Record-Stockman. D.[c]	Denver.
	Field and Farm. W	Do.
	Ranch News. M	Do.
	Sugar Beet Grower. W	Do.
Connecticut	Connecticut Farmer. W	Hartford.
	New England Tobacco Grower. M	Do.
	Poultry Standard. M	Stamford.
District of Columbia	American Farmer and Gardener. M	Washington.
	Feather. M	Do.
	Forestry and Irrigation. M	Do.
	National Homemaker. M	Do.
Florida	Florida Agriculturist. W	De Land.
	Florida Times-Union and Citizen. S-W.[d]	Jacksonville.
	Supplement. W	De Land.
Georgia	Nut-Grower. M	Poulan.
	Plowboy and Country Farmer. M	Atlanta.
	Southern Cultivator and Dixie Farmer. S-M.[e]	Do.
	Southern Fancier. M	Do.
	Southern Farmer. M	Athens.
	Southern Pit Games. M	Blakely.
Idaho	Gem State Rural. W	Caldwell.
Illinois	Agricultural Advertising. M	Chicago.
	American Bee Journal. W	Do.
	American Fancier and Breeder. W	Dekalb.
	American Field. W	Chicago.
	American Florist. W	Do.
	American Horse Owner. M	Do.
	American Poultry Journal. M	Do.
	American Sheep-Breeder and Wool-Grower. M	Do.
	American Swineherd. M	Do.
	Arboriculture. M	Do.
	Beet Sugar Gazette. M	Do.
	Breeder's Gazette. W	Do.
	Chicago Daily Drovers Journal. D	Do.
	Chicago Dairy Produce. W	Do.
	Chicago Live Stock World. D	Do.
	Commercial Poultry. S-M	Do.
	Corn Belt. M	Do.
	Dairy and Creamery. S-M	Do.
	Dairy World. M	Do.
	Farm, Field, and Fireside. W	Do.
	Farm Implement News. W	Do.
	Farmer's Call. W	Quincy.
	Farmer's Institute. M	Carbondale.
	Farmers' Review. W	Chicago.
	Farmer's Voice and National Rural. W	Do.
	Florists' Review. W	Do.
	Garden and Farm. M	Springfield.
	Gardening. S-M	Chicago.
	Goodall's Farmer and Weekly Drovers' Journal. W.	Do.
	Horse Review. W	Do.
	Horseman. W	Do.
	Hospodářské Listy. S-M	Do.
	Irrigation Age. M	Do.

[a] Weekly. [b] Monthly. [c] Daily. [d] Semiweekly. [e] Semimonthly.

Periodicals published in the United States—Continued.

State or Territory.	Name of periodical.	Post-office.
Illinois	Live Stock Journal. W	Chicago.
	Live Stock Report. W	Do.
	Milk News. M	Do.
	National Fanciers' Journal. M	Hinsdale.
	Orange Judd Farmer. W	Chicago.
	Our Horticultural Visitor. M	Kinmundy.
	Poultry Keeper. M	Quincy.
	Prairie Farmer. W	Chicago.
	Reliable Poultry Journal. M	Quincy.
	Wool Markets and Sheep. S-M	Chicago.
Indiana	Agricultural Epitomist. M	Spencer.
	American Farmer. M	Indianapolis.
	Drainage Journal. M	Do.
	Fanciers' Gazette. M	Do.
	Indiana Farmer. W	Do.
	Indianapolis Daily Live Stock Journal. D	Do.
	Inland Poultry Journal. M	Greenfield.
	Jersey Bulletin. W	Indianapolis.
	Up to Date Farming and Gardening. M	Do
	Western Horseman. W	Do.
Iowa	Creamery Journal. M	Waterloo.
	Farmer and Breeder. S-M	Sioux City.
	Farmers' Institute. M	Mason City.
	Farmers' Tribune. W	Des Moines.
	Fruitman. M	Mount Vernon.
	Homestead. W	Des Moines.
	Iowa Agriculturist. M	Ames.
	Poultry, Bee, and Fruit Journal. M	Davenport.
	Poultry Farmer. M	Des Moines.
	Poultry Success. M	Do.
	Red-polled Record. M	Maquoketa.
	Sioux City Live Stock Record. D	Sioux City.
	Spirit of the West. W	Des Moines.
	Wallace's Farmer. W	Do.
	Western Poultry Journal. M	Cedar Rapids.
Kansas	Industrialist. M	Manhattan.
	Kansas Farmer. W	Topeka.
	Poultry Gazette. M	Do.
	Western Breeder's Journal. M	Clay Center.
Kentucky	Fancy Fowls. M	Hopkinsville.
	Farmers' Home Journal. W	Louisville.
	Home and Farm. S-M	Do.
	Kentucky Stock Farm. W	Lexington.
	Thoroughbred Record. W	Do.
Louisiana	Louisiana Planter and Sugar Manufacturer. W	New Orleans.
Maine	Eastern Poultryman. M	Freeport.
	Lewiston Weekly Journal. W	Lewiston.
	Maine Farmer. W	Augusta.
	Turf, Farm, and Home. W	Waterville.
Maryland	New Farm. W	Preston.
	Poultry and Farm. M	Baltimore.
	Southern Farm Magazine. M	Do.
Massachusetts	American Cultivator. W	Boston.
	American Horse Breeder. W	Do.
	American Stock Keeper. W	Do.
	Farm and Home. Eastern edition. S-M	Springfield.
	Farm-poultry. S-M	Boston.
	Massachusetts Ploughman. W	Do.
	New England Farmer. W	Do.
	Our Dumb Animals. M	Do.
	Pigeon News. S-M	Do.
Michigan	American Cheese Maker. M	Grand Rapids.
	Dog Fancier. M	Battle Creek.
	Game Fancier's Journal. M	Do.
	Michigan Farmer. W	Detroit.
	Michigan Poultry Breeder. M	Battle Creek.
	Michigan Sugar Beet. W	Bay City.
	Threshermen's Review. M	St. Joseph.
Minnesota	Agricultural Experiments. M	Minneapolis.
	American Stock Farm. M	Winona.
	Cigar and Tobacco Journal. M	Minneapolis.
	Farm implements. M	Do.
	Farm, Stock, and Home. S-M	Do.
	Farm Students' Review. M	St. Anthony Park.
	Farmer. S-M	St. Paul.
	Farmers' tribune. S-W	Minneapolis.
	Northwestern Agriculturist. S-M	Do.
	Poultry Herald. M	St. Paul.
	Skandinavisk Farmer Journal. W	Minneapolis.
Missouri	American Angora and Stockman. M	Kansas City.
	Barnum's Midland Farmer. S-M	St. Louis.
	Colman's Rural World. W	Do.

Periodicals published in the United States—Continued.

State or Territory.	Name of periodical.	Post-office.
Missouri	Country Home. M	St. Louis.
	Daily National Live Stock Reporter. D	Do.
	Farm Machinery. W	Do.
	Horse Show Monthly. M	Do.
	Implement Trade Journal. S-M	Kansas City.
	Kings and Queens of the Range. M	Do.
	Magic City Hoof and Horn. W	South Omaha.
	Missouri and Arkansas Farmer and Fruitman. M	Kansas City.
	Missouri and Kansas Farmer. M	Do.
	Modern Farmer and Busy Bee. M	St. Joseph.
	National Farmer and Stock Grower. M	St. Louis.
	Orff's Farm and Poultry Review. M	Do.
	Poultry Culture. M	Kansas City.
	Poultry Topics. M	St. Joseph.
	Practical Fruit Grower. S-M	Springfield.
	St. Louis Journal of Agriculture. W	St. Louis.
Montana	Montana Stockman and Farmer. S-M	Helena.
	Rocky Mountain Husbandman. W	White Sulphur Springs.
Nebraska	Agriculture. M	Lincoln.
	Hospodár. Bi-W[a]	Omaha.
	Nebraska Dairyman. M	Lincoln.
	Nebraska Farm Journal. M	Do.
	Nebraska Farmer. W	Omaha.
	Twentieth Century Farmer. W	Do.
	Western Swine Breeder. M	Lincoln.
New Hampshire	Mirror and Farmer. W	Manchester.
New Jersey	Homing Exchange. M	Vineland.
	Milk Reporter. M	Sussex.
	Peach Growers' Journal. M	Do.
New York	American Agriculturist. W	New York.
	American Fancier. W	Johnstown.
	American Gardening. W	New York.
	American Homes. M	Do.
	American Poultry Advocate. M	Syracuse.
	Country Gentleman. W	Albany.
	Farmers' Institute Bulletin. Q.[b]	Fayetteville.
	Florists' Exchange. W	New York.
	Fruitman's Guide. W	Do.
	Green's Fruit Grower and Home Companion. M	Rochester.
	Horse World. W	Buffalo.
	Jersey Advocate and Dairyman. W	New York.
	National Nurseryman. M	Rochester.
	New York Farmer. W	Port Jervis.
	New York Produce Review and American Creamery. W.	New York.
	Practical Poultryman and Poultry Star. S-M	Fayetteville.
	Rider and Driver. W	New York.
	Rural New Yorker. W	Do.
	Spirit of the Times. W	Do.
	Tobacco. W	Do.
	Tobacco Leaf. W	Do.
	Tobacco World. W	Do.
	Turf, Field, and Farm. W	Do.
	United States Tobacco Journal. W	Do.
	Vick's Family Magazine. M	Rochester.
North Carolina	Agricultural Education. Q	West Raleigh.
	Carolina Fruit and Truck Grower's Journal. S-M	Wilmington.
	Progressive Farmer. W	Raleigh.
	Progressive Farmer. W	Do.
	Southern Tobacco Journal. W	Winston-Salem.
	Strawberry Specialist. M	Kittrell.
	Trucker. W	Chadbourn.
North Dakota	Cando Record. W	Cando.
Ohio	Agricultural Student. M	Columbus.
	American Grange Bulletin. W	Cincinnati.
	Cincinnati Live Stock Review. W	Do.
	Farm and Fireside. S-M	Springfield.
	Farm News. M	Do.
	Gleanings in Bee Culture. S-M	Medina.
	Home and Flowers. M	Springfield.
	Ohio Farmer. W	Cleveland.
	Ohio Poultry Journal. M	Dayton.
	Western Tobacco Journal. W	Cincinnati.
Oklahoma	Oklahoma Farmer. W	Guthrie.
Oregon	Baker's Pacific States Farmer, Stockman, and Dairyman. M.	Portland.
	North Pacific Rural Spirit. W	Do.
	Northwest-Pacific Farmer. W	Do.
	Northwest Poultry Journal. M	Salem.
	Oregon Agriculturist and the Rural Northwest. S-M.	Portland.
	Pacific Homestead. W	Salem.

[a] Bi-weekly. [b] Quarterly.

Periodicals published in the United States—Continued.

State or Territory.	Name of periodical.	Post-office.
Pennsylvania	American Fertilizer. M	Philadelphia.
	Blooded Stock on the Farm. M	Oxford.
	Country Journal. M	Allentown.
	Country Life in America. M	Harrisburg.
	Export Implement Age. M	Philadelphia.
	Farm Journal. M	Do.
	Farmer's Friend. M	Mechanicsburg.
	Gleaner. W	Doylestown.
	House and Garden. M	Philadelphia.
	Implement Age. S-M	Do.
	National Stockman and Farmer. W	Pittsburg.
	Park's Floral Magazine. M	Libonia.
	Pigeon Flying. M	Philadelphia.
	Practical Farmer. W	Do.
	Rural Farmer. W	Do.
	Sugar Beet. M	Do.
South Carolina	Cotton Plant. W	Greenville.
South Dakota	Dakota Farmer. S-M	Aberdeen.
	Sioux Stock Journal. W	Fort Pierre.
	Western Progress. M	Scotland.
Tennessee	Cotton and Farm Journal. S-M	Memphis.
	Cotton Planters' Journal. S-M	Do.
	Dixie Game Fowl. M	Columbia.
	Southern Agriculturist. S-M	Nashville.
	Tennessee Farmer. W	Do.
	Tri-State Farmer and Gardener. M	Chattanooga.
Texas	Farm and Ranch. W	Dallas.
	National Fancier. M	Belton.
	Rice Industry. M	Houston.
	Southern Poultry Journal. M	Dallas.
	Texas Farm Journal. W	Do.
	Texas Farmer. W	Do.
	Texas Stockman and Farmer. W	San Antonio.
	Truck Farmer. M	Dallas.
	West Texas Sentinel and Stock Farmer. W	Abilene.
Virginia	Cornucopia. M	Norfolk.
	Southern planter. M	Richmond.
	Southern Tobacconist. W	Do.
	Southern Workman. M	Hampton.
Washington	Northwest Horticulturist. M	Tacoma.
	Western Home Journal and Inter Mountain Poultry Journal. M.	Spokane.
West Virginia	West Virginia Farm Review. M	Charleston.
Wisconsin	American Thresherman. M	Madison.
	Geflügel-Züchter (Der). M	Hamburg.
	Hoard's Dairyman. W	Fort Atkinson.
	Wisconsin Agriculturist. W	Racine.
	Wisconsin Farmer. W	Madison.
	Wisconsin Sugar Beet. M	Menomonee Falls.

Foreign periodicals.

Country.	Name of periodical.	Post-office.
Algeria	Bulletin Agricole de l'Algérie et de la Tunisie. S-M	Alger-Mustapha.
Argentine Republic	Revista de la Facultad de Agronomía y Veterinaria La Plata. M.	La Plata.
Austria	Land- und Forstwirthschaftliche Unterrichts-Zeitung. Q.	Wien.
	Wiener illustrirte Garten-Zeitung. M	Do.
	Zeitschrift für das Landwirthschaftliche Versuchswesen in Oesterreich. M.	Do.
Barbados	Agricultural News. S. M	Barbados.
	West Indian Bulletin. Q	Do.
Belgium	Belgique (La) Horticole et Agricole. S-M	Bruxelles.
	Écho (L') Vétérinaire. M	Liége.
	Industrie (L') Laitière Belge. W	Bruxelles.
	Ingénieur (L') Agricole de Gembloux. M	Gembloux.
	Laiterie (La) Belge. M	Renaix.
	Journal des Sociétés Agricoles du Brabant et du Hainault. W.	Bruxelles.
	Revue Générale Agronomique. M	Louvain.
	Revue Générale du Lait. S-M	Lierre.
	Tuinbode (De). M	Gent.
Brazil	Boletim da Agricultura. M	São Paulo.
	Lavoura (A); Boletim da Sociedade Nacional de Agricultura [brazileira]. M.	Rio de Janeiro.
	Revista (La) Agricola. M	São Paulo.
Canada	Breeders' Advocate. M	Petrolea.
	Canadian Horticulturist. M	Toronto.

Foreign periodicals—Continued.

Country.	Name of periodical.	Post-office.
Canada	Canadian Implement and Vehicle Trade. M	Toronto.
	Canadian Poultry News. M	Owen Sound.
	Canadian Poultry Review. M	Toronto.
	Farmer's Advocate. S-M	Winnipeg.
	Journal of Agriculture and Horticulture. S-M	Montreal.
	Maritime Farmer. S-M	Sussex, N. B.
	Nor'-west Farmer. S-M	Winnipeg.
	Weekly Sun. W	Toronto.
Cape of Good Hope	Agricultural Journal. S-M	Cape Town.
Ceylon	Tropical Agriculturist. M	Colombo.
Cuba	Agricultor (El) Cubano. M	Habana.
	Tabaco (El). S-M	Do.
Denmark	Landmands-blade. W	København.
	Maanedskrift for Dyrlæger. M	Do.
	Mælkeritidende. W	Odense.
England	Agricultural Economist. M	London.
	Agricultural Gazette. W	Do.
	Agricultural Students' Gazette. 3 nos. annually	Cirencester.
	Country Life. W	London.
	Dairy. M	Do.
	Dairy World. M	Do.
	Farm and Home. W	Do.
	Field (The), the Farm, the Garden. W	Do.
	Garden. W	Do.
	Gardener's Chronicle. W	Do.
	Gardening. W	Do.
	International Sugar Journal. M	Manchester.
	Journal of Horticulture. W	London.
	Live Stock Journal. W	Do.
	Mark Lane Express and Agricultural Journal. W	Do.
	Rural World. M	Do.
	Veterinarian. M	Do.
	Veterinary Journal. M	Do.
Finland	Finsk Veterinärtidskrift. Bi-M.[a]	Wiborg.
	Tidning för mjölkhushållning. W	Hangö.
France	Agriculture (L') Pratique des Pays Chauds. Bi-M	Paris.
	Annales Agronomiques. M	Do.
	Annales de la Science Agronomique	Do.
	Apiculteur (L'). M	Do.
	Engrais (L'). W	Lille.
	Industrie (L') Laitière. W	Paris.
	Jardin (Le). S-M	Do.
	Journal Agricole. M	Do.
	Journal d'Agriculture Pratique. W	Do.
	Journal d'Agriculture Pratique et d'Economie Rural pour le Midi de la France. M.	Toulouse.
	Journal d'Agriculture Tropicale. M	Paris.
	Laiterie (La) et les Industries de la Ferme. Bi-W	Do.
	Pomologie (La) Française. M	Do.
	Progrès Agricole et Viticole. W	Montpellier.
	Recueil de Médecine Vétérinaire. S-M	Paris.
	Revue de Viticulture. W	Do.
	Revue des Cultures Coloniales. S-M	Do.
	Revue Horticole. S-M	Do.
	Revue Vétérinaire. M	Toulouse.
	Semaine (La) Agricole. W	Paris.
	Sucrerie (La) Indigène et Coloniale. W	Do.
	Tabac (Le). M	Do.
	Vigne (La) Américaine et la Viticulture en Europe. M.	Mâcon.
Germany	Archiv für Wissenschaftliche und Praktische Thierheilkunde. Bi-M.	Berlin.
	Berliner Thierärztliche Wochenschrift. W	Do.
	Blätter für Zuckerrübenbau. S-M	Do.
	Braunschweigische Landwirthschaftliche Zeitung. W.	Braunschweig.
	Deutsche Landwirthschaftliche Presse. S-W	Berlin.
	Deutsche Thierärztliche Wochenschrift. W	Hannover.
	Deutsche Zuckerindustrie. W	Berlin.
	Fühlings Landwirthschaftliche Zeitung. S-M	Stuttgart.
	Hessische Landwirthschaftliche Zeitschrift. W	Darmstadt.
	Journal für Landwirthschaft. Q	Berlin.
	Landwirthschaftliche Jahrbücher. Bi-M	Do.
	Landwirthschaftliche Wochenschrift für die Provinz Sachsen. W.	Halle. a. S.
	Landwirthschaftliche Zeitschrift für die Rheinprovinz. W.	Bonn.
	Landwirthschaftlichen (Die) Versuchsstationen. Bi.-M.	Berlin.
	Landwirthschaftliches Wochenblatt für Schleswig-Holstein. W.	Kiel.
	Milch-Zeitung. W	Leipzig.
	Molkerei-Zeitung. W	Hildesheim.

Foreign periodicals—Continued.

Country.	Name of periodical.	Post-office.
Germany	Möller's Deutsche Gärtner-Zeitung. W	Erfurt.
	Monatshefte für Praktische Thierheilkunde. W	Stuttgart.
	Proskauer Obstbau-Zeitung. M	Proskau.
	Rosen-Zeitung. Bi-M	Trier.
	Sächsische Landwirthschaftliche Zeitschrift. W	Dresden.
	Schleswig-holsteinische Blätter für Geflügelzucht. M.	Kiel.
	Thierarzt (Der). M	Wetzlar.
	Thierärztlicher Central-Anzeiger. S-M	Berlin.
	Wochenschrift für Thierheilkunde und Viehzucht. W.	München.
	Württembergisches Wochenblatt für Landwirthschaft. W.	Stuttgart.
	Zeitschrift für Thiermedicin. Bi-M	Jena.
	Zeitschrift für Veterinärkunde. M	Berlin.
Guatemala	República (La) Agrícola. M	Guatemala.
India	Indian Agriculturist. M	Calcutta.
	Indian Gardening and Planting. W	Do.
	Indian Planters' Gazette. W	Do.
Ireland	Farmers' Gazette. W	Dublin.
	Irish Farming World. W	Do.
Italy	Bulletino dell' Agricoltura. W	Milano.
	Clinica (La) Veterinaria. W	Do.
	Stazioni (Le) Sperimentali agrarie italiane. M	Modena.
Japan	Agriculturist. 3 numbers monthly	Tokyo.
Java	Veeartsenijkundige Bladen voor Nederlandsch-Indië. Q.	Batavia.
Mexico	Agricultor (El) Mexicano. M	Mexico.
	Boletín de Agricultura, Minería é Industrias. M	Do.
Natal	Agricultural Journal and Mining Record. Bi-W	Pietermaritzburg.
Netherlands	Tijdschrift voor Veeartsenijkunde. M	Utrecht.
New South Wales	Agricultural Gazette of New South Wales. M	Sydney.
	Australian Bee Bulletin. M	West Maitland.
	Station, Farm and Dairy. M	Sydney.
Norway	Norsk Havetidende. M	Christiania.
	Norsk Landmandsblad. W	Kristiania.
	Norsk Veterinær-tidsskrift. Q	Do.
Portugal	Archivo Rural; Gazeta dos Lavradores. S-M	Lisboa.
Queensland	Queensland Agricultural Journal. M	Brisbane.
Réunion Island	Revue Agricole: Organe des Cultivateurs de la Réunion. M	Saint-Denis.
Russia	Arkhiv Veterīnarnuikh Nauk. M	S-Peterburg.
	Kavkazskoe selskoe Khozyaĭstvo. W	Tiflis.
	Selskoe Khozyaĭstvo ī Lyesovodstvo. M	S-Peterburg.
	Zemledyelcheskaya Ghazeta. W	Do.
	Zemledyelie. W	Kiev.
Scotland	Scottish Farmer. W	Glasgow.
South Australia	Australian Garden and Field. W	Adelaide.
	Journal of Agriculture and Industry of South Australia. M	Do.
Spain	Veterinaria (La) Española. 3 numbers monthly	Madrid.
Straits Settlements	Agricultural Bulletin of the Straits and Federated Malay States. M	Singapore.
Sweden	Landtmannen. W	Linköping.
	Nordisk Mejeri-tidning. W	Stockholm.
Switzerland	Chronique Agricole du Canton de Vaud. S-M	Lausanne.
	Landwirthschaftliches Jahrbuch der Schweiz. (Two editions; German and French.) M.	Berne.
	Revue Internationale d'Apiculture. M	Nyon.
	Schweizer-Archiv fur Tierheilkunde. Bi-M	Zürich.
Tasmania	Agricultural Gazette and Journal of the Council of Agriculture. M.	Hobart.
Victoria	Journal of the Department of Agriculture of Victoria. M.	Melbourne.
	Australasian Pastoralists' Review. M	Do.
Western Australia	Journal of the Department of Agriculture of Western Australia. M	Perth.

FREE DELIVERY OF RURAL MAILS.

APPROPRIATIONS BY CONGRESS.

Rural free delivery having been accepted by Congress, the Post-Office Department, and the country as a permanent and indispensable feature of post-office administration, the appropriations for the continuance and extension of the service are progressing in a rapid ratio.

The bill making appropriations for the postal service in the United States for the fiscal year commencing July 1, 1903, and ending June 30, 1904, provides specifically for the rural free-delivery service $12,621,700. This includes compensation for 8 division superintendents, 70 special agents, 69 route inspectors, clerks of division headquarters, rural carriers, clerks in charge of substations of rural free delivery, and all traveling and incidental expenses. Appropriations of Congress for this service during the previous fiscal year amounted to $8,154,400.

The increase of appropriation thus indicated does not imply an increased expenditure to the full amount as shown, for the extension of the rural free-delivery service results in the discontinuance of other service by star-route carriers paid by contracts under the Second Assistant Postmaster-General, and the closing of fourth-class post-offices whose postmasters are paid by retention of the cancellations of their offices. These changes effect a large reduction in the aggregate expenses of the service considered as a whole; in some cases the reductions equal or even exceed the cost of the rural free delivery, which takes up the service.

POPULATION SERVED.

The total population served by the rural free-delivery service up to April 30, 1903, is estimated at 7,400,000 people. This is an increase of 1,580,000 over last year, but still leaves about 19,000,000 people in communities eligible for the rural service awaiting its extension to them. The work of developing the service is proceeding at a rate corresponding with the increase of appropriation. On April 30, 1903, there were 14,813 routes starting from 6,525 offices, as against 8,438 routes in operation at a corresponding time last year; and there were pending unacted on at that time 10,539 petitions for new routes, as against 9,904 at a corresponding period in the previous fiscal year.

ORGANIZATION.

The rural free delivery is organized under the First Assistant Postmaster-General, by whom the direct supervision of the work is committed to the general superintendent of the free-delivery system. The principal officials are a superintendent in charge of installation, a superintendent in charge of inspection of the service established and of the investigation of complaints, and 138 special agents and route inspectors detailed for active service in the field. All these officers, as well as the subordinate clerical force employed under their direction, are now included under the rules of the civil service, both as to appointment and removal.

ESTABLISHMENT OF SERVICE.

The delivery of mails by rural carriers is extended in response to petitions presented by the people desiring the service upon forms prepared by the Department, which include a diagram of the proposed route. It is required that the route shall be from 20 to 25 miles in length, so laid out that the carrier will not have to traverse the same road on his return as on his outward trip, and so adjusted that at least 100 domiciles shall be included in the service. Such a petition, when presented to the Department with the approval of the Congressional Representative of the district or of one of the Senators from the State in which the service is asked for, is investigated by one of the special agents in the field, who transmits the papers, with a map of the route or routes to be followed, to the Superintendent in Washington for his adjudication.

RURAL CARRIERS—THEIR PAY AND DUTIES.

Applicants for the position of rural carrier are subjected to a very simple examination in respect to their qualifications for the service and the esteem in which they are held by the inhabitants along the routes they are to serve. The limits of age are from 17 to 55 years, except in the case of physically competent veterans of the civil war or the Spanish war.

The annual pay of the rural carrier is $600, payable monthly, out of which he must provide his own horse and vehicle. The practice of wearing uniform is not obligatory, but is generally followed. Carriers are permitted to carry passengers and unmailable packages for pay, provided this does not interfere with the proper handling of mails. Under certain restrictions, also, a carrier may act as news agent and carrier for newspapers. The carrier delivers and collects mail all along the route, usually from approved boxes provided by the patrons along the roadside at such height that he can reach them without alighting from his vehicle. Any metal box conforming to requirements as to size, shape, opening, and security is accepted by the Department, provided it has been first submitted to and approved by the special agent in charge of the division in which the box is manufactured or in which it is to be offered for sale. As a rule the carrier leaves the post-office at which his work begins as soon as possible after the arrival and distribution of the principal morning mail, and returns in time to dispatch his collection by the evening mail. He cancels all letters collected by him, mailing them in the post-office from which his service originates, unless they require delivery en route. He is empowered to register and deliver registered letters and to give receipts for money orders. He carries a supply of stamps for sale and is authorized to affix the requisite postage to unstamped letters and packages provided the necessary money is deposited in the roadside box with the mail.

Each carrier must furnish a bond for $500 and provide a substitute similarly bonded who will perform the duties when the carrier is disabled or absent. In such case the substitute receives the carrier's pay for the period during which his principal is absent from duty, but the certificates of service are made out in the name of the carrier. Postmasters can grant rural carriers leave of absence for a few days in emergency, but absence for longer periods must receive the formal approval of the Department. The practice of subletting rural deliveries to substitutes is not tolerated.

The following table shows the number of routes and applications by States for the years 1902 and 1903:

Rural free-delivery routes and petitions for routes.

States and Territories.	April 1, 1903.		May 1, 1902.	
	Routes in operation.	Petitions pending.	Routes in operation.	Petitions pending.
Alabama	121	198	48	84
Arizona	5	3	2	3
Arkansas	39	22	15	29
California	144	42	103	53
Colorado	47	37	41	27
Connecticut	179	21	131	34
Delaware	81	19	55	12
Dist. Columbia	2	....	....	2
Florida	3	20	1	3
Georgia	419	573	213	453
Hawaii	....	1	....	....
Idaho	12	13	12	16
Illinois	1,290	757	701	927
Indian Territory	....	5	....	1
Indiana	1,108	499	626	502
Iowa	1,464	480	778	796
Kansas	719	484	470	580
Kentucky	183	158	37	137
Louisiana	5	13	5	3
Maine	146	114	114	72
Maryland	270	57	197	38
Massachusetts	128	58	84	60
Michigan	802	502	472	637
Minnesota	619	352	270	424
Mississippi	57	110	3	38
Missouri	697	495	387	571
Montana	1	16	1	13
Nebraska	366	368	207	361
Nevada	....	2	....	....
New Hampshire	119	24	93	32
New Jersey	94	54	71	37
New Mexico	2	1	1	2
New York	942	373	562	343
North Carolina	300	367	116	362
North Dakota	40	37	19	15
Ohio	1,090	849	745	893
Oklahoma	20	146	9	67
Oregon	78	36	28	63
Pennsylvania	827	529	469	375
Rhode Island	18	5	15	5
South Carolina	233	240	145	222
South Dakota	125	53	52	79
Tennessee	546	530	269	420
Texas	270	323	153	355
Utah	27	6	12	18
Vermont	124	79	78	62
Virginia	233	339	75	219
Washington	52	38	37	22
West Virginia	68	62	51	54
Wisconsin	611	420	380	383
Wyoming	5	....	5	....
Total	14,741	9,930	8,458	9,904

PUBLIC LANDS OPEN FOR SETTLEMENT.

The figures given in the table below show the location of the public lands in the United States still open for occupation under the homestead and other laws for acquisition of title by individuals. In general, the lands noted in the column "Area surveyed" are available for immediate private occupation under any of the laws now in force for grant of title by the Government. The lands scheduled as "Unsurveyed" must, of course, be surveyed before a grant can be made. The column head "Area appropriated" indicates roughly to what extent the section where the lands are located is already settled and under cultivation.

Applications for and information regarding public lands should be addressed to the registers and receivers of the United States district land offices in the places noted in the table. Full information should be obtained before any move is made toward occupation of these lands.

At the last session of Congress a new homestead law was passed for Alaska. By its provisions the size of the homestead in Alaska that will be given to any citizen of the United States who can qualify under the restrictions of the law is increased from 80 to 320 acres.

Lands open for settlement and location of land offices in the United States, June 30, 1902.

[Abridged from Report of Commissioner of General Land Office.]

State and location of office.	Area unappropriated.		Area appropriated.
	Area surveyed.	Area unsurveyed.	
ALABAMA.	*Acres.*	*Acres.*	*Acres.*
Huntsville	134, 910	....	7, 756, 690
Montgomery	169, 150	....	24, 545, 650
ARIZONA.			
Prescott	5, 508, 142	19, 015, 416	3, 505, 286
Tucson	5, 648, 204	17, 121, 900	2, 268, 665
ARKANSAS.			
Camden	703, 901	....	7, 809, 039
Dardanelle	988, 322	....	3, 181, 178
Harrison	852, 820	....	4, 388, 180
Little Rock	463, 172	....	15, 154, 508
CALIFORNIA.			
Eureka	2, 886, 804	260, 443	2, 122, 366
Independence	8, 796, 725	3, 608. 674	706, 938
Los Angeles	8, 066, 848	2, 719, 291	5, 860, 136
Marysville	725, 328	170, 955	4, 084, 614
Redding	2, 567, 600	266, 158	4, 406, 690
Sacramento	879, 299	289, 538	2, 259, 937
San Francisco	3, 708, 234	208, 824	10, 692, 360
Stockton	713, 199	53, 510	4, 727, 073
Susanville	4, 675, 774	254, 412	1, 619, 097
Visalia	581, 669	119, 149	5, 905, 005
COLORADO.			
Akron	865, 322	....	2, 152, 178
Del Norte	2, 233, 602	605, 860	1, 176, 058
Denver	4, 673, 993	335, 090	5, 712, 217
Durango	2, 982, 078	468, 611	656, 011
Glenwood Springs	6, 406, 948	1, 266, 296	1, 007, 254
Gunnison	1, 752, 157	532, 753	424, 010
Hugo	1, 566, 226	....	835, 935
Lamar	3, 173, 264	....	1, 898, 736
Leadville	1, 412, 376	305, 144	681, 660
Montrose	3, 090, 591	776, 303	622, 066
Pueblo	5, 011, 435	6, 240	5, 098, 943
Sterling	962, 123	....	2, 000, 377
FLORIDA.			
Gainesville	1, 275, 244	160, 070	33, 618, 067
IDAHO.			
Blackfoot	3, 420, 478	2, 982, 772	4, 018, 250
Boise	4, 179, 613	7, 358, 483	1, 398, 485
Cœur d'Alene	613, 889	2, 561, 284	1, 243, 598
Hailey	3, 340, 380	12, 535, 904	1, 205, 853
Lewiston	820, 948	4, 488, 908	1, 793, 284
KANSAS.			
Colby	90, 858	....	6, 172, 922
Dodge City	614, 710	....	15, 542, 390
Topeka	....	....	22, 258, 245
Wakeeney	274, 040	....	6, 441, 680

Lands open for settlement and location of land offices in the United States, June 30, 1902—Continued.

State and location of office.	Area unappropriated.		Area appropriated.
	Area surveyed.	Area unsurveyed.	
LOUISIANA.	*Acres.*	*Acres.*	*Acres.*
Natchitoches	68,455	65,018	3,882,681
New Orleans	76,600		23,491,172
MICHIGAN.			
Marquette	386,170		36,312,495
MINNESOTA.			
Crookston	356,958	1,116,080	7,359,282
Duluth	1,130,577	903,428	5,635,367
Marshall			17,144,060
St. Cloud	46,100		12,505,780
MISSISSIPPI.			
Jackson	152,540		29,532,580
MISSOURI.			
Boonville	67,266		26,233,734
Ironton	85,719		9,911,281
Springfield	116,556		7,381,284
MONTANA.			
Bozeman	1,752,484	3,915,916	3,385,640
Helena	7,256,600	9,605,037	6,254,017
Kalispell	553,049	3,751,293	1,606,158
Lewiston	3,122,891	2,911,873	2,097,718
Miles City	4,406,432	19,414,592	2,495,516
Missoula	362,754	4,385,593	1,315,620
NEBRASKA.			
Alliance	2,550,177		3,307,021
Brokenbow	2,116,022		1,918,698
Lincoln	4,625		11,854,655
McCook	186,552		5,686,448
North Platte	617,457		3,807,864
O'Neill	621,919		8,013,081
Sidney	529,866		2,736,294
Valentine	2,354,239		2,225,751
NEVADA.			
Carson City	30,154,755	31,145,063	3,053,413
NEW MEXICO.			
Clayton	7,376,851	419,404	1,050,745
Las Cruces	13,704,286	5,492,658	1,377,381
Roswell	9,297,117	5,861,313	1,359,836
Santa Fe	10,443,287	2,562,200	13,098,541
NORTH DAKOTA.			
Bismarck	5,790,580	3,833,361	7,391,559
Devils Lake	348,940		4,984,780
Fargo	94,800		7,862,270
Grand Forks	24,760		4,150,520
Minot	3,862,897	1,116,139	1,123,984
OKLAHOMA.			
Alva	10,681		1,721,319
Elreno	7,826		2,696,706
Guthrie	90		2,377,845
Kingfisher	240,174		3,480,409
Lawton	22,802		1,504,158
Mangum	113,001		1,971,785
Oklahoma			1,069,435
Woodward	3,395,402		2,407,918
OREGON.			
Burns	5,992,689	1,556,420	1,744,791
Lagrande	4,058,214	1,020,601	3,560,672
Lakeview	7,708,888	3,242,240	2,210,052
Oregon City	537,279	161,190	5,675,115
Roseburg	1,350,319	1,949,314	6,519,830
The Dalles	3,950,571	345,946	3,814,898
SOUTH DAKOTA.			
Aberdeen	123,650		3,190,598
Chamberlain	1,438,835	91,035	1,292,673
Huron	41,591		4,333,694
Mitchell	3,284		7,165,716
Pierre	1,557,130		1,389,113
Rapid City	7,819,618	306,831	2,488,956
Watertown	1,439		5,170,561

Lands open for settlement and location of land offices in the United States, June 30, 1902—Continued.

State and location of office.	Area unappropriated.		Area appropriated.
	Area surveyed.	Area unsurveyed.	
UTAH.	*Acres.*	*Acres.*	*Acres.*
Salt Lake City	10,865,862	31,242,617	4,858,893
WASHINGTON.			
North Yakima	535,432	802,785	2,474,700
Olympia	73,217	174,633	2,710,984
Seattle	241,875	825,385	3,584,701
Spokane	616,915	1,906,271	4,850,173
Vancouver	426,653	440,353	3,287,008
Walla Walla	654,599	298,003	2,212,107
Waterville	2,396,425	1,680,715	2,007,781
WISCONSIN.			
Ashland	67,744		2,978,923
Eau Claire	32,689		14,252,191
Wausau	38,811		17,539,169
WYOMING.			
Buffalo	6,487,559	768,897	1,127,690
Cheyenne	8,571,865	88,078	3,051,867
Douglas	7,552,220	226,998	728,782
Evanston	9,240,509	1,468,680	1,416,814
Lander	4,148,321	425,715	566,946
Sundance	4,804,471		934,206

LAND TENURE IN THE UNITED STATES.

In most of the States of the United States lands are held by individuals under the authority of the State governments, and all questions in regard to real estate holdings are to be settled in the State courts. In many cases, especially in the States formed since the original Union was established, the title runs back to a patent from the United States, but this does not change the status of such lands in their relation to the State governments.

In the Territories the lands are under the control of the Territorial governments. Questions concerning them are brought before the Territorial courts and may in some cases be carried on appeal to the United States circuit court of appeals, and in others to the Supreme Court of the United States.

Land titles may originate in a United States grant or patent, in a State grant or patent, in a grant from one of the European governments which exercised authority over the early settlers of this country, or in a grant from Mexico, which at one time owned a great region in the Southwest, now constituting the States and Territories from Texas to California. A safe origin of title may also be found in the decree of a court having proper jurisdiction, or in actual possession, except as against the Government, by a mere squatter for a term of years fixed by statute.

To secure a good title to lands in the United States at the present time a grant or patent of public lands must be obtained from the United States Government; of State lands from a State government; a tax title or other title under a decree of court; or a grant from some person or corporation whose title traces without flaw to one of these sources.

If real estate is bought of a person or corporation care must be exercised to see that the chain of title back to the Government or court is perfect. It is a custom now to have an abstract made, showing the several grants and changes of holding along with any incumbrances and evidence of their removal, all complete from Government to present holder. The buyer in many instances requires such an abstract.

In the older States, especially those settled soon after the Revolution, early surveys were inaccurate and uncertain and grants overlapped each other. In addition to overlapping there is sometimes the difficulty that a State has given as many titles to a piece of land as persons could be found willing to pay the State officer's fee for the patent. In consequence there are instances where seven or eight State patents to the same lands are in existence. The question of priority, carrying ownership, must then be determined by the courts.

In many States disputes over land titles have been very burdensome and laws have been passed with a view to settling them finally. These laws have usually taken the form of statutes of limitation. They fix a time beyond which the holder of lands can not be questioned as to his title. Usually the period of this bar is much longer

for the limitation against the State's right to recover possession than against the individual claimant, and against the right of the United States Government to recover there is no limitation. The periods fixed by the several States as a bar against private claims are given in the following table:

Limitation of action in land cases by States and Territories.

Alabama	10	Louisiana	30	Oklahoma	5
Alaska		Maine	20	Oregon	10
Arizona	15	Maryland	20	Pennsylvania	7
Arkansas	7	Massachusetts	20	Rhode Island	10
California	5	Michigan	15	Samoa	
Colorado	5	Minnesota	15	South Carolina	10
Connecticut	15	Mississippi	10	South Dakota	20
District of Columbia	15	Missouri	10	Tennessee	7
Delaware	20	Montana	10	Texas	10
Florida	7	Nebraska	10	Utah	7
Georgia	20	Nevada	5	Vermont	15
Idaho	5	New Hampshire	20	Virginia [a]	10 and 15
Illinois	20	New Jersey	20	Washington	10
Indian Territory		New Mexico	10	West Virginia	10
Indiana	20	New York	20	Wisconsin	20
Iowa	5	North Carolina	20	Wyoming	10
Kansas	15	North Dakota	21		
Kentucky	15	Ohio	20		

[a] Virginia, east of Alleghenies, 15; west of Alleghenies, 10.

COTTON EXCHANGES.

City and State.	Name of organization.	Secretary.
Atlanta, Ga	Chamber of Commerce	Walter G. Cooper.
Augusta, Ga	Exchange and Board of Trade	Clarence S. Cates.
Birmingham, Ala	Commercial Club	J. B. Gibson.
Charleston, S. C	Cotton Exchange	James M. Seignious (pres.).
Columbia, S. C	Chamber of Commerce	E. J. Watson.
Columbus, Ga	Board of Trade	John C. Coart.
Dallas, Tex	Commercial Club	John G. Hunter.
Eufaula, Ala	Cotton Exchange	
Fort Worth, Tex	Board of Trade	
Galveston, Tex	Cotton Exchange and Board of Trade.	Dr. S. O. Young.
Greenville, Miss	Cotton Exchange	Edward Holland.
Greenwood, Miss	do	C. K. Marshall.
Houston, Tex	Cotton Exchange and Board of Trade.	W. J. de Treville.
Little Rock, Ark	Board of Trade	Geo. R. Brown.
Memphis, Tenn	Cotton Exchange	Henry Hotter.
Meridian, Miss	Board of Trade and Cotton Exchange.	J. H. Stoltzfus.
Mobile, Ala	Cotton Exchange	R. H. Bolling (supt.).
Monroe, La	Board of Trade	E. D. Windes.
Montgomery, Ala	Commercial and Industrial Ass'n	L. L. Gilbert.
Nashville, Tenn	Chamber of Commerce	L. R. Eastman.
Natchez, Miss	Cotton and Merchants' Exchange	W. E. Fitzpatrick.
Newbern, N. C	Cotton and Grain Exchange	James Redmond.
New Orleans, La	Cotton Exchange	H. G. Hester.
New York, N. Y	do	Frederick Van Riper.
Norfolk and Portsmouth, Va	do	
Raleigh, N. C	Cotton and Grocers' Exchange	
Richmond, Va	Grain and Cotton Exchange	
Rome, Ga	Board of Trade	
St. Louis, Mo	Merchants' Exchange	Geo. H. Morgan.
Savannah, Ga	Cotton Exchange	
Selma, Ala	do	
Sherman, Tex	Commercial Club	
Shreveport, La	Board of Trade	Henry Hawkins.
Texarkana, Ark	Commercial Club	
Vicksburg, Miss	Cotton Exchange	
Waco, Tex	Business Men's Club	
Wilmington, N. C	Produce Exchange	John L. Cantwell.
Yazoo City, Miss	Cotton Exchange	

BOARDS OF TRADE.

City and State.	Name of organization.	Secretary.
Baltimore, Md	Chamber of Commerce	H. A. Wroth.
Boston, Mass	do	
Buffalo, N. Y	Merchants' Exchange	F. Howard Mason.
Chicago, Ill	Board of Trade	Geo. F. Stone.
Cincinnati, Ohio	Chamber of Commerce	Chas. B. Murray, superintendent.
Cleveland, Ohio	do	F. A. Scott.
Columbus, Ohio	Board of Trade	J. Y. Bassell.
Denver, Colo	Chamber of Commerce and Commercial Club.	Arthur Williams.
Detroit, Mich	Board of Trade	F. W. Waring.
Duluth, Minn	do	
Indianapolis, Ind	do	
Louisville, Ky	do	J. F. Buckner, jr.
Memphis, Tenn	Merchants' Exchange	N. S. Graves.
Milwaukee, Wis	Chamber of Commerce	
Minneapolis, Minn	do	Geo. D. Rogers.
New York, N. Y	Produce Exchange	J. C. Brown, statistician.
Omaha, Nebr	Board of Trade	L. C. Harding.
Peoria, Ill	do	
Philadelphia, Pa	Commercial Exchange	Armon D. Acheson.
Do	Produce Exchange	Howard Austin.
Portland, Oreg	Board of Trade	Max M. Shillock.
Richmond, Va	Chamber of Commerce	R. A. Dunlop.
St. Louis, Mo	Merchants' Exchange	Geo. H. Morgan.
San Francisco, Cal	Chamber of Commerce	E. Scott.
Do	Merchants' Exchange	T. C. Friedlander.
Seattle, Wash	Chamber of Commerce	James B. Meikle.
Toledo, Ohio	Produce Exchange	
Washington, D. C	Board of Trade	Geo. H. Harries.

STATE STANDARDS FOR DAIRY PRODUCTS, 1903.

State.	Milk.			Skim milk.	Cream.	Butter.	Cheese.
	Total solids.	Solids not fat.	Fat.	Total solids.	Fat.	Fat.	Fat.
	Per cent.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per cent.*	
California							Full cream, 30 p. c. fat. Half skim, 15 p. c. fat. Skim, from skim milk. (Fancy cheese excepted.)
Colorado							Full cream, 35 p. c. total solids to be fat. Skim, fat less than 35 p. c. of total solids.
Dist. of Columbia		9	3.5	9.3	20	83 Not over 12 p. c. water or 5 p.c. salt.	
Georgia		8.5	3.5	Less than 3.5 p. c. fat or 8.5 p. c. solids not fat.			
Illinois[a]	12		3		[b]15	80	Whole milk, 48 p. c. total solids to be fat.
Indiana		9	3			80 Not over 15 p. c. water or 6 p.c. salt.	Skim milk, less than 10 p. c. fat.
Iowa	12.5		3		15		
Maine	12		3				
Massachusetts	13	9.3	3.7	9.3			
April–September	12	9	3				
Michigan	12.5		3				
	Sp. grav. 1.029–33			Sp. grav. 1.032–37			

[a] Condensed milk shall be made from milk containing at least the legal standard of 3 per cent butter fat and evaporated to one-third or less of its original volume.
[b] Coffee cream shall contain at least 15 per cent of fat, and whipping cream 22 per cent fat.

State standards for dairy products, 1903—Continued.

State.	Milk.			Skim milk.	Cream.	Butter	Cheese.
	Total solids.	Solids not fat.	Fat.	Total solids.	Fat.	Fat.	Fat.
	Per cent.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per cent.*	
Minnesota	13		3.5		20		Full cream, 45 p. c. total solids to be fat. Skim, fat less than 45 p. c. of total solids.
Missouri							Full cream, from 3 p. c. milk. Skim, from milk less than 3 p. c. fat.
Nebraska			3		15		
New Hampshire	13						
New Jersey	12						
New York[a]	12		3				Skim, from skim milk.
North Dakota	12		3		15		Do.
Ohio[a]	12		3			80	Full cream, 20 p. c. fat. Skim, less than 20 p. c. fat.
May and June	11.5						
Oregon[a]	12	8	3	Sp. grav. 1.038	20	Not over 14 p. c. water.	40 p. c. total solids to be fat.
Pennsylvania (Milk and skim-milk standards refer to cities of second and third class.)	12.5 Sp. grav. 1.029–33		3	2.5 p. c. fat. 6 p. c. cream by vol. Sp. grav. 1.032–37			Full cream, 32 p. c. fat. Three-fourths cream, 24 p. c. fat. One-half cream, 16 p. c. fat. One-fourth cream, 8 p. c. fat. Skim, below 8 p. c. fat. (Fancy cheese weighing less than 5 pounds excepted.)
Rhode Island	12		2.5				
South Carolina		8.5	3	Less than 3 p. c. fat or 8.5 p. c. solids not fat.			
South Dakota							Full cream, 45 p. c. total solids to be fat. Skim, fat less than 45 p. c. total solids.
Utah				9 p. c. solids not fat.			
Vermont	12.5	9.25		[b]4			
May and June	12						
Washington		8	3		18		Full cream, 30 p. c. fat. Skim, 15 p. c. fat. (Fancy cheese excepted.)
Wisconsin			3				Skim, size regulated.

[a] In New York, Ohio, and Oregon the milk solids of condensed milk shall be in quantity the equivalent of 12 per cent of milk solids in crude milk, of which solids 25 per cent shall be fat.
[b] As basis for payment at factories.

FARMERS' INSTITUTES.

Variation of methods in farmers' institute work in the several States is such that statistics collected do not afford an accurate basis of comparison. Especially the item of attendance represents such a diversity of estimate that it only shows roughly what is being accomplished. In Maryland, for example, the figures are only for persons who were known to be really interested in the proceedings, not mere spectators, while in most cases the total attendance was counted.

In Oklahoma there are thirteen chartered county institutes, some of which hold monthly meetings. In December, 1902, these elected a board of agriculture of six, which has a secretary charged with arranging for an annual institute in every county. The figures in the table, however, are for institutes held by agricultural college officers.

No reports have been received of farmers' institute work in the following States and Territories: Alaska, Arkansas, Georgia, New Mexico, Porto Rico, South Dakota, and Wyoming.

Statistics of farmers' institutes.

States and Territories.	Means of support.		Speakers.		Meetings.				Reports of proceedings.		
	State funds.	Other funds.	Staff.	Other.	Total number.	Two days or more.	Average attendance.	Twice in same place.	Published.	Number of copies.	Remarks as to distribution.
Alabama	Tag tax.	Hatch fund.	8	......	24	....	109	....	No..	....	
Arizona	....	....	......	......	2	....	175	....	......	....	
California	$4,000	....	8	3	80	70	250	....	No..	....	Brief résumé.
Colorado	None.	Local.	......	25	15	6	......	....	......	....	
Connecticut	3,500	....	......	20	12	....	......	....	No..	....	
Delaware	600	....	3	15	17	5	115	3	No..	....	Newspaper reports.
Florida	2,500	....	25	......	22	4	150	....	No..	....	
Hawaii	None.	....	4	......	4	....	45	1	Yes.	....	General distribution.
Idaho	1,000	....	5	6	20	20	150	....	Yes.	6,000	By mail.
Illinois	18,150	County.	1	100	109	....	368	8	Yes.	....	
Indiana	10,000	Dues.	......	......	201	....	200	....	......	....	
Iowa	6,900	....	......	......	68	68	100	....	No..	....	Papers in agricultural report.
Kansas	2,000	....	17	None.	85	9	499	2	No..	....	Newspaper reports.
Kentucky	Varying.	Local.	......	......	8	8	200	....	Yes.	10,000	Supplements of newspapers.
Louisiana	2,000	....	4	3	45	3	294	....	Yes.	3,000	Free to farmers.
Maine	3,000	....	......	......	37	....	160	....	Yes.	....	Papers in agricultural report.
Maryland	4,000	9	9	......	116	93	97	....	No..	....	
Massachusetts	....	....	......	......	128	....	20	....	......	....	
Michigan	7,500	Fees.	1	25	246	63	407	....	Yes.	8,000	To institute members.
Minnesota	16,500	....	10	None.	89	20	337	....	Yes.	30,000	Institute annual.
Mississippi	1,500	....	14	4	56	4	100	....	......	....	
Missouri	4,000	....	25	......	127	77	200	2	Yes.	....	Principal lectures.
Montana	2,000	....	6	......	17	4	63	....	Yes.	5,000	By mail.
Nebraska	4,000	....	14	13	a86	47	300	....	No..	....	
Nevada	None.	....	6	2	1	....	45	....	......	....	
New Hampshire	Indefinite.	....	10	10	20	....	200	....	Yes.	2,000	Do.
New Jersey	600	....	1	30	17	5	115	2	No..	....	Newspaper reports.
New York	20,000	$3,500	81	20	269	12	352	....	Yes.	25,000	At institutes.
North Carolina	322	Local.	......	7	17	....	100	1	Yes.	20,000	
North Dakota	1,500	....	3	4	24	24	121	....	Yes.	10,000	Do.
Ohio	....	8,347	30	......	249	249	343	....	Yes.	10,000	
Oklahoma	....	Dues.	None.	5	11	3	50	1	No..	....	
Oregon	None.	Local.	......	......	19	....	175	....	No..	....	
Pennsylvania	15,000	None.	51	14	189	135	445	....	Yes.	31,600	By legislature.
Rhode Island	Indefinite.	None.	None.	......	1	....	30	....	Yes.	2,500	
South Carolina	....	1,051	8	1	13	1	400	....	......	....	
Tennessee	2,016	....	......	......	....	....	......	....	......	....	
Texas	None.	Local.	......	......	....	....	......	....	......	....	
Utah	1,500	....	8	37	44	....	165	....	Yes.	5,000	By mail.
Vermont	4,000	....	3	12	50	15	200	....	......	....	
Virginia	Indefinite.	....	3	......	47	....	300	....	No..	....	
Washington	....	....	......	......	31	....	50	....	......	....	
West Virginia	5,000	....	9	......	79	69	200	....	Yes.	7,600	
Wisconsin	12,000	....	30	......	122	112	450	....	Yes.	60,000	By clubs.

[a] October, 1901, to June, 1902.

METRIC WEIGHTS AND MEASURES.

The base unit of length in the metric system is the meter, which is one ten-millionth of the quadrant from the equator to the pole; the base unit of area (square measure) is the are, which is one square dekameter; of cubic measure the stere, which is a cubic meter. The base unit of weight is the gram, which is the weight at sea level of a cubic centimeter of distilled water at 4° C. nearly; the base unit of capacity is the liter (one cubic decimeter) which holds distilled water enough, at 4° C. nearly, to weigh one kilogram at sea level.

The following tables furnish the equivalents of the principal units in the metric and English systems of weights and measures:

Metric units in English equivalents.

Meter .....39. 37 inches......3. 28083 feet..............1. 09361 yards.
Kilometer .0. 621 mile ....3, 280. 83 feet..............1, 093. 61 yards.

Metric units in English equivalents—Continued.

Are	0.024 acre	1,076.4 square feet	119.60 square yards
Hektare	2.471 acres	107.64 square feet	11,960 square yards.
Stere	0.2759 cord	35.3165 cubic feet	1.308 cubic yards.
Liter	33.8 fluid ounces	1.0567 quarts (liquid)	0.02838 bushel.
Gram	15.43234 grains	0.03527 ounce avoirdupois	0.0022 pound avoirdupois.
Kilogram	15432 grains	35.27 ounces avoirdupois	2.2 pounds avoirdupois.

English units in metric equivalents.

Foot	0.3048 meter	3.048 decimeters	30.48 centimeters.
Mile	1,609.344 meters	1.609 kilometers	16.09 hektometers.
Acre	40.4685 ares	0.4047 hectare.	
Cord	3.624 steres	3624 cu. decimeters	3.624 cu. meters.
Perch (of masonry)	0.7 stere	700 cu. decimeters	0.700 cu. meter.
Gallon (U.S.)	3.7854 liters	0.037 hektoliter	378.54 centiliters.
Pound	0.4535 kilogram	4.535 hektograms	453.5 grams.
Ton (2,000 pounds)	907.1 kilograms	0.9071 tonne	907,100 grams.
Bushel	35.237 liters	0.035 cu. meter	35.23 kilograms.

TEMPERATURES, FAHRENHEIT AND CENTIGRADE.

The centigrade zero is placed at the freezing point while the Fahrenheit zero is 32° below the freezing point. The space between the freezing point and the boiling point is divided into 100° on the centigrade scale and 180° on the Fahrenheit scale. The remainder of the scale on each is divided in the same ratio. To convert centigrade readings into Fahrenheit: If the number given has the plus sign (+), multiply it by 9 and divide the product by 5; to the quotient add 32 and the sum will be the Fahrenheit reading corresponding to that given in centigrade. If the given centigrade reading is minus, multiply it by 9 and divide by 5; take the difference between the quotient and 32; if the quotient is greater than 32, give the difference the minus sign (−); otherwise give the difference the plus sign. The result will be in degrees Fahrenheit. Examples:

$$-25^\circ \text{ C.}=\frac{9\times25}{5}-32=-13^\circ \text{ F.};\quad -5^\circ \text{ C.}=32.\frac{9\times5}{5}=23^\circ \text{ F.}$$

IMPORTANT DATA AS TO FIELD CROPS.

The data presented in the following tables rest upon the opinions of experts at the State experiment stations. Some inaccuracies have been corrected for the present publication, but suggestions and corrections, with a statement of the extent of experience upon which they are based, will continue to be welcome.

It is not intended to state anything with rigid exactness. Dates of planting, time required for maturing, and quantities of seed are made to cover the extremes. In wheat and other grains both spring and winter are included in the range given. Kinds and quantities of manure are suggested, but, of course, only for locations where manure is needed. In several States hardly any manure is ever used. Kansas, Iowa, Oklahoma, and South Dakota report no commercial fertilizers and very little manure in field operations. Prof. I. P. Roberts, of the Cornell Experiment Station, recently wrote in answer to an inquiry: "We have at this station long contended for better tillage and rational methods of applying farm manures and fertilizers. * * * We have proved with experiments extending over six years that far greater stress should be laid on tillage and that far less manure should be applied per acre for any one crop than is usually applied." In the Atlantic States commercial fertilizers are much used and reliable figures are desired.

In any particular case the farmer must decide from the conditions before him whether manure is needed. The table will then give him some suggestion as to kind and quantity.

The yields and prices noted for cereals are based upon the tables for 1900, compiled by the Division of Statistics of this Department. The yields show the State averages for that year from the poorest up to the best. The varieties of seed noted are believed to represent those most common, but it is not known that a thorough investigation has ever been made. Indeed, changes of preference and use occur so frequently that only a special inquiry every year would give results nearly accurate.

As to dates of planting, Prof. E. J. Wickson, of California, says: "All kinds of grain except buckwheat are sown here from September to March, according to local climates. The same is true of potatoes and grain sown for hay. Very tender things, like beans, tobacco, and squashes, are confined to spring planting."

Time of planting, quantity of seed, yield, prices, etc., for several regions.

NEW ENGLAND.

Kind of crop.	Date of planting.	Best soil.	Amount of manure per acre.	Amount of seed per acre.	Weeks to maturity.	Average yield per acre (bushels).	Range of price per bushel.	Standard varieties.
Corn	May 10 to 30	Sandy or clay loam	8 to 12 tons	8 to 12 qts	14–17	32–40	$0.50–$0.67	Leaming, Sanford, Flint.
Wheat	Fall or spring	Clay loam	18 tons	2 bush	20	16–24	.77– .92	
Oats	Apr. to May	Strong loam	6 to 8 tons	2 to 3 bush	11–15	31–38	.35– .38	White.
Barley	Apr. to June 20	....do	7 to 8 tons	....do	10–15	23–28	.52– .77	
Rye	Apr. to May, Sept.	Medium loam	....do	5 to 6 pecks	40	16–17	.65– .82	Do.
Buckwheat	June 1 to 20	Light loam	4 to 6 tons	1 to 1¼ bush	10–15	16–30	.49– .72	
White beans	May to June	Sandy loam	7 to 8 tons	8 to 16 qts	8–14	16–20	1.75– 2.50	
Potatoes	Apr. 15 to May 1	Rich loam	15 to 20 tons	8 to 20 bush	12–20	80–350	.30– 1.25	Green Mountain, Carmon 3, Rose.
Turnips	July 1 to Aug. 3	Sandy loam	10 tons	1 lb	10	200–500	.15– .35	Yellow.
Mangels	Apr. 15 to May 5	Strong heavy loam	8 to 15 tons	4 to 6 lbs	17–22	a 20–30	b 3.00	Long Red, Sugar.
Tobacco	Seed bed Apr	Sandy loam	8 to 12 tons		9–12	c 800–1,800	d .05– .50	
Hay								

MIDDLE STATES.

Kind of crop.	Date of planting.	Best soil.	Amount of manure per acre.	Amount of seed per acre.	Weeks to maturity.	Average yield per acre (bushels).	Range of price per bushel.	Standard varieties.
Corn	Apr. 20 to May 30.	Medium loam	8 to 12 tons manure	6 to 8 qts	16–18	24–33	$0.38–$0.47	Leaming, White Dent, Yellow Dent.
Wheat	Sept. 20 to Oct. 20.	Loam	8 tons; 300 lbs. fer.	2 bush	41–43	14–20	.70– .82	Fultz.
Oats	Mar. to May	Moist clay loam	....do	2 to 2½ bush	16–17	21–31	.30– .32	White, Black.
Barley	....do	Clay loam	....do	....do	13–16	19–27	.50	Manshury.
Rye	Sept. 1 to Oct. 1	Sand or gravel loam	....do	1½ bush	40–43	15–16	.53– .56	White Winter.
Buckwheat	June to July	Loam	5 tons	½ to 1½ bush	8–10	13–16	.52– .59	Silver Hull.
White beans	May to June	Sandy loam	8 tons	1½ bush	13–14	20	.90– 1.25	Navy.
Potatoes	Mar. to May	Loam	10 to 18 tons	8 to 15 bush	14–22	75–300	.30– .75	Burbank, Cobbler, Rural 2.
Sweet potatoes	May to June	Sandy loam		10 to 12 bush	10–15	100–200	.25– 1.00	Yellow Jersey.
Cabbage	Mar. to July	Clay or sandy loam	300 to 600 lbs fer.	4 to 8 oz	8–15		.01– .10	Dutch.
Turnips	July	Loam		2 to 5 lbs	10–12	300	.15– .25	Purple Top.
Mangels	May	....do	10 to 20 tons	10 to 15 bush	15–18	23–28		Long Red.
Flax	....do	Limestone loam		20 qts	8–10	10–12	.56	Rega, White Blossom, Dutch.
Tobacco	Seed bed, Mar	Sandy loam	Commercial fer		15–20	c 1,000–1,500	d .04– .20	
Hay, timothy	Aug. to Oct	Clay loam		6 to 8 qts		a 1–2	10.00–16.00	
Hay, clover	Feb. to Apr	....do		6 qts		a 1–3	8.00–12.00	Medium red.

CENTRAL AND WESTERN STATES.

Corn	Apr. 1 to June 1	Black or sandy loam	5 to 10 tons	6 qts	16–20	15–40	\$0.26–\$0.64	Leaming, Sanford, Flint, White Dent.
Wheat	Fall or spring	Strong loam	8 tons	1½ to 2 bush	40–42	6–27	.46– .79	Fultz, Poole, Fife, Turkey red.
Oats	Mar. 10 to May 1	Clay loam	do	2 to 3 bush	12–14	10–38	.20– .46	Gray Norway, Silver Mine, Russian.
Barley	Fall or spring *e*	do	do	2 bush	11–13	9–37	.31– .62	
Rye	Sept. 1 to 31	Light loam	do	1 to 2 bush	35–40	5–19	.39– .61	Winter.
Buckwheat	June	Clay loam	5 tons	do	10–12	13–16	.51– .77	Silver Hull.
White beans	May 10 to June 10	do	8 tons	1½ bush	12	14–25	.40– 1.00	Navy.
Potatoes	Mar. 15 to June 1	Sandy loam	5 to 10 tons	5 to 10 bush	10–20	80–300	.10– .70	Hebron, Rural, Early Rose.
Turnips	July 15 to Aug. 30	Loam or muck	8 to 10 tons	1 to 6 lbs	10–16	500–700	.05– .25	
Mangels	Apr. 1 to May 15	Sandy loam	8 to 12 tons	6 to 8 lbs	22–24	500–1,000		
Flax	Mar. 15 to May 15	Loam	10 to 15 tons	2 to 3 pecks	15–20	10–18	.75– 1.50	
Tobacco	Seed bed, Mar	Sandy loam	8 to 10 tons	Oz. to 6 sq. rd.	15–18	*c* 600–1,000	*d* .02– .20	Yellow Pryor, Spanish, White Burley.
Hay	Apr. to May	Clay loam	10 tons	8 to 15 lbs		*a* 2.4		
Kafir corn	Apr. to June	Upland	None	3 to 6 quarts	15–25	15–40	.20– .50	Black cap white, Red.

SOUTHERN STATES.

Cotton	Mar. to May 15	Sandy loam *f*		1 to 3 bush	20–30	*c* 100–500	*d* \$0.07–\$0.09	Russel's Big Bole, Schley.
Corn	Feb. to June	Rich loams	10 bush. cot. seed	8 qts	18–20	7–27	.40– .64	Hickory King, Gourdseed, Blount's Prolific.
Wheat	Sept. to Dec	Clay loam, clay *f*	8 tons	2 bush	43	9–20	.64– 1.00	Fulcaster, Turkey.
Oats	Feb., May, Sept	do	8 to 10 tons	1 to 3 bush	17	11–38	.30– .50	Texas Rust-proof, Burt.
Barley	Sept. to Oct	do	do	2 to 4 bush	17	15–29	.55– .72	Tennessee winter.
Rye	do	do	10 tons	1 to 2 bush	43	7–16.5	.52– 1.05	Georgia.
White beans	Mar. to May	Light loam	8 tons	do	7–8	90–100		Navy.
Cabbage	Oct., Mar. to May	do	6 to 10 tons	¼ to ½ lb	14	10	.01– .10	Wakefield, Flat Dutch, Charleston.
Watermelons	Mar. 1 to May 10	Rich, light loam	5 tons; 300 lbs. fer.	2 to 7 lbs	16–20			Jones, Rattlesnake.
Onions	Feb. 1 to Apr. 10	Loam or muck			16–24	300	1.75– 2.00	Red Potato.
Potatoes	Jan., Feb. to Apr	Light, loose loam	8 to 12 tons	8 to 10 bush	11–15	100–300	.40– 1.00	Bliss, Triumph.
Sweet potatoes	Apr. to July	Sandy loam		10 to 12 bush	12–15	100–200	.25– 1.00	Providence.
Pumpkins	Apr. 1 to May 1	Rich, light loam		4 to 7 lbs	17–20			
Tomatoes	Jan. 1 to Feb. 19	Rich, sandy loam		4 to 9 oz	14–20	400–600	1.00– 1.25	Crimsoncushion, Ponderosa.
Turnips	Feb., Aug., Apr	Rich, light loam		2 to 6 lbs	8–12	*a* 5		Purple top.
Tobacco	Seed bed, Mar	Sandy loam	8 to 15 tons	Oz. to 6 sq. rd.	18–20	*c* 600–1,000	*d* .03– .20	
Cowpeas	May 1 to July 15	do	200 to 300 lbs. phos.	2 to 5 pecks	6–8	10–20	.70– 1.75	Whippoorwill, Little iron.

a Tons. *b* Per ton. *c* Pounds. *d* Per pound. *e* Spring wheat is little more grown in Ohio, Indiana, Illinois, and many other States. It matures in 18 to 20 weeks. *f* In Texas the black loam is a good soil for cotton, corn, wheat, and most other field crops.

WEIGHTS OF THE BUSHEL.

Legal standards for leading agricultural products in the United States.

States and Territories.	Wheat.	Rye.	Oats.	Barley.	Buckwheat.	Shelled corn.	Corn on cob.	Corn meal and rye meal.	Bran.	Malt.	Potatoes, Irish.	Potatoes, sweet.	Carrots.	Onions.	Turnips, English.	Beets.	Beans.	Peas.	Apples, peaches, pears, quinces.	Dried apples.	Dried peaches.	Castor beans.	Flaxseed.	Hemp seed.	Millet seed.	Timothy seed.	Blue-grass seed.	Hungarian grass seed.	Clover seed.	Legislative enactments.
Alabama	60	56	32	47	....	56	70	*a*48	....	....	60	55	....	....	55	....	60	60	....	*b*24	*b*38	....	....	....	....	....	....	....	....	Acts Feb. 18, 1891.
Alaska	60	56	32	48	42	56	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	U. S. Statute.
Arizona	60	56	32	45	....	54	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	Comp. Laws, 1877.
Arkansas	60	56	32	48	52	56	70	48	20	....	60	50	....	57	57	....	60	60	50	24	33	....	56	....	50	55	14	....	60	Act Mar. 30, 1887.
California	60	54	32	50	40	52	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	Code and Stat., 1886.
Colorado	60	56	32	48	52	56	70	50	....	....	60	....	....	57	....	....	60	....	....	....	....	....	....	44	....	45	14	....	60	Gen. Stat., 1883.
Connecticut	60	56	32	48	48	56	....	50	20	....	60	54	50	52	50	60	60	60	48	25	33	....	55	....	....	45	....	....	60	Gen. Stat., 1902.
Delaware	60	....	....	....	....	56	....	*c*48	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	
District of Columbia	60	56	32	48	48	56	70	48	20	38	60	55	....	57	55	....	60	....	....	26	33	46	56	44	50	45	44	50	60	U. S. Statute.
Florida	60	56	32	48	....	56	70	48	20	....	60	55	....	56	54	....	*d*60	....	*e*48	24	33	48	....	....	50	....	....	....	....	Stat., 1901.
Georgia	60	56	32	47	52	56	70	48	20	....	60	55	....	57	55	....	60	60	....	24	38	....	56	44	....	45	14	....	60	Code, 1895.
Hawaii	60	56	32	48	42	56	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	U. S. Statute.
Idaho	60	56	36	48	42	56	....	....	....	....	60	....	....	....	....	....	....	....	*h*45	28	28	....	56	....	....	....	....	....	60	Code, 1901.
Illinois	60	56	32	48	52	....	70	48	20	38	60	50	....	57	55	....	60	....	....	24	33	46	56	44	....	45	14	....	60	Law, 1889.
Indiana	60	56	32	48	50	56	*f*68	50	....	....	60	55	....	48	55	....	60	....	....	25	33	46	....	44	50	45	14	....	60	Rev. Stat., 1901.
Indian Territory	60	56	32	48	42	56	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	U. S. Statute.
Iowa	60	56	32	48	52	56	70	....	20	....	60	46	....	57	....	....	60	....	....	24	33	46	56	44	48	45	14	48	60	Rev. Code, 1897.
Kansas	60	56	32	48	50	....	70	50	20	32	60	50	....	57	55	....	60	....	48	24	33	46	56	44	50	45	14	50	60	Gen. Stat., 1901.
Kentucky	60	56	32	47	56	56	*g*70	50	20	....	60	55	....	57	60	....	60	60	....	24	39	45	56	44	50	45	14	50	60	Gen. Stat., 1888.
Louisiana	60	56	32	48	....	56	72	....	....	....	....	56	....	54	58	....	60	....	....	....	....	....	....	....	50	....	....	....	....	Rev. Laws, 1884.
Maine	60	56	32	48	48	56	....	50	....	....	60	....	50	52	50	60	62	60	*h*44	....	....	....	....	....	....	45	....	....	....	Rev. Stat., 1883, and Acts, 1887.
Maryland	60	56	*i*26	48	48	56	70	50	20	34	56	56	40	56	56	50	56	56	....	28	*b*32	60	56	44	50	45	14	48	60	Code, 1888.
Massachusetts	60	56	32	48	48	56	....	50	20	....	60	54	50	52	....	....	60	60	48	25	33	....	55	....	*k*35	45	....	....	60	Rev. Laws, 1902.
Michigan	60	56	32	48	48	56	70	50	....	....	60	56	....	54	58	....	60	60	48	22	28	46	56	44	50	45	14	50	60	Annot. Stat., 1882.
Minnesota	60	56	32	48	50	56	70	....	....	....	60	55	45	52	52	50	60	60	50	28	28	....	56	50	48	45	14	48	60	Rev. Stat., 1897.
Mississippi	60	56	32	48	42	56	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	Code, 1892.
Missouri	60	56	32	48	52	56	70	50	20	38	60	56	50	57	42	....	60	60	48	24	33	46	56	44	50	45	14	48	60	Rev. Stat., 1899.
Montana	60	56	32	48	52	56	70	*l*50	20	30	60	....	50	57	50	50	60	60	45	....	....	....	56	44	....	45	14	50	60	Stat., 1888, 1901.
Nebraska	60	56	32	48	52	56	70	50	20	30	60	50	....	57	55	....	60	60	....	24	33	46	56	44	50	45	14	50	60	Stat., 1891.
Nevada *m*	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	
New Hampshire	60	56	32	....	....	56	....	50	....	....	60	....	....	....	....	....	60	60	....	....	....	....	....	....	....	....	....	....	....	Stat., 1891.
New Jersey	60	56	30	48	50	56	....	....	....	....	60	54	....	57	....	....	60	60	*n*50	25	33	....	55	....	....	....	....	....	64	Laws, 1881.
New Mexico	60	56	32	48	42	56	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	Stat., 1852.
New York	60	56	32	48	48	56	....	50	20	....	60	51	50	57	....	....	60	60	48	25	33	....	55	....	....	45	....	....	60	Gen. Laws.

North Carolina	60	56	32	48	50	56	....	o48	....	....	....	....	....	....	....	....	....	60	....	....	....	....	55	....	....	....	....	....	60	Act. Jan. 31, 1885.
North Dakota	60	56	32	48	42	56	70	....	20	....	60	46	50	52	60	60	60	60	....	....	....	....	56	41	50	42	14	48	60	Code, 1899.
Ohio	60	56	32	48	50	56	68	....	....	34	60	50	50	55	60	56	60	60	p48	24	33	....	56	44	50	45	....	50	60	Act, 1893.
Oklahoma	60	56	32	48	42	56	70	....	....	....	60	46	....	52	60	60	60	60	....	....	....	46	56	....	50	42	....	....	60	Laws, 1893.
Oregon	60	56	32	46	42	56	....	....	....	....	60	....	....	....	....	....	....	....	45	28	28	....	....	....	....	....	....	....	60	Laws, 1901.
Pennsylvania	60	56	32	47	48	56	....	....	....	....	56	....	....	50	....	....	....	....	....	....	....	....	....	....	....	....	....	....	60	Digest, 1883.
Philippines	60	56	32	48	42	56	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	U. S. Statute.
Porto Rico	60	56	32	48	42	56	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	U. S. Statute.
Rhode Island	60	56	32	48	48	56	70	50	20	....	60	54	50	50	50	50	60	60	....	....	....	....	56	44	50	45	14	50	60	Pub. Laws, 1900.
Samoa	60	56	32	48	42	56	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	U. S. Statute.
South Carolina	60	56	32	48	42	56	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	U. S. Statute.
South Dakota	60	56	32	48	42	56	70	....	20	....	60	46	....	52	60	60	60	60	....	....	....	....	56	....	....	42	....	....	60	Laws, 1887.
Tennessee	60	56	32	48	50	56	70	50	20	....	60	50	50	56	50	50	60	30	50	24	26	46	56	41	50	45	14	48	60	Act, 1887.
Texas	60	56	32	48	42	56	70	....	20	....	60	55	....	57	55	....	60	....	....	....	28	....	56	44	50	45	....	48	60	Act, Apr. 10, 1883.
Utah	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	
Vermont	60	56	32	48	48	56	....	....	....	....	60	....	50	52	52	60	62	60	46	....	....	....	....	....	....	45	....	....	60	Laws, 1880, 1884.
Virginia	60	56	32	48	52	56	70	50	....	38	56	56	....	57	55	....	60	60	....	28	q40	....	56	44	50	45	14	48	60	Code, 1887.
Washington	60	56	32	48	42	56	....	(r)	(r)	(r)	60	(s)	(s)	(s)	(s)	(s)	(s)	(s)	45	28	28	....	56	....	....	....	....	....	60	Stat., 1897.
West Virginia	60	56	32	48	52	56	....	....	....	....	60	....	....	....	....	....	....	....	....	25	33	....	56	....	....	45	....	....	60	Code, 1887.
Wisconsin	60	56	32	48	48	56	70	50	....	34	60	54	50	57	42	50	60	60	48	25	33	....	55	44	50	45	....	48	60	Laws, 1881.
Wyoming	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	Laws, 1899.

a Bolted, 46.
b Peeled.
c Sifted, 44.
d Velvet beans in hull, 78.
e Pears, 60.
f Before Dec. 1, 70.
g May 1 to Nov. 1, 68.
h Apples and pears.
i Trade usage, 32.
k Japanese barnyard millet.
l Corn meal.
m No law.
n Apples.
o Bolted corn meal, 48.
p Apples, 50.
q Unpeeled, 32.
r Sold by 2,000 pounds or sack.
s Sold by ton or 100 pounds.

NOTE.—The figures given for Alaska, Hawaii, Indian Territory, the Philippines, Porto Rico, and Samoa are from the United States Revised Statutes of 1878, and are fixed for the customs service. The same figures are given for Mississippi, New Mexico, and South Carolina under the State and Territory laws noted. In much of the Pacific coast and Rocky Mountain regions transactions are by weight rather than by measure.

STATISTICS OF THE PRINCIPAL CROPS.[a]

CORN.

The corn crop of the United States in 1902 was 2,523,648,312 bushels, with a farm value, on December 1, of over a billion dollars. In production and farm value this exceeds any crop heretofore reported, surpassing the crop of 1901 by over a billion bushels, and taking position as the record crop.

The average yield per acre for 1902 was 26.8 bushels for the whole country, as against 16.7 in 1901, 28.2 in 1896, and a 10-year average of 23.9 bushels.

There was a marked falling off in exports of corn and corn products for the fiscal year ending June 30, 1902, as compared with the six preceding years, due to the reduced crop yield of 1901.

The monthly average prices of corn were exceptionally high in 1902, and the yearly average was about 60 cents per bushel at Chicago. The visible supply the first of each month decreased gradually from 17,197,000 bushels in February to 3,823,000 bushels in September. Wholesale prices of cash corn ranged higher in 1902 than for many previous years, advancing gradually from 56½ cents at Chicago in January to 88 cents in July, falling back to 54 cents in August, and rising again to 62½ cents in September.

Corn crop of the world, 1897–1901.

Country.	1897.	1898.	1899.	1900.	1901.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
United States	1,902,968,000	1,924,185,000	2,078,144,000	2,105,103,000	1,522,520,000
Canada (Ontario)	25,441,000	24,181,000	22,356,000	27,947,000	25,621,000
Mexico	121,893,000	111,347,000	93,438,000	92,204,000	80,000,000
Total North America	2,050,302,000	2,059,713,000	2,193,938,000	2,225,254,000	1,628,141,000
Chile	8,000,000	9,932,000	9,000,000	8,000,000	9,000,000
Argentina	40,000,000	56,000,000	72,000,000	60,000,000	78,000,000
Uruguay	4,000,000	4,000,000	6,000,000	3,035,000	5,576,000
Total South America	52,000,000	69,932,000	87,000,000	71,035,000	92,576,000
France	30,401,000	23,496,000	25,548,000	22,232,000	26,393,000
Spain	19,644,000	14,098,000	24,667,000	26,016,000	23,000,000
Portugal	15,500,000	15,500,000	16,000,000	16,000,000	15,000,000
Italy	65,891,000	79,640,000	88,536,000	83,286,000	95,176,000
Austria	14,757,000	16,074,000	14,583,000	15,446,000	17,212,000
Hungary	103,910,000	127,382,000	115,981,000	127,656,000	132,000,000
Croatia-Slavonia	14,608,000	20,822,000	14,680,000	18,691,000	19,000,000
Total Austria-Hungary	133,275,000	164,278,000	145,244,000	161,793,000	168,212,000
Roumania	79,753,000	101,907,000	27,721,000	85,047,000	116,945,000
Bulgaria and E. Roumelia	25,000,000	37,759,000	20,462,000	18,000,000	30,000,000
Servia	16,000,000	24,558,000	15,000,000	18,472,000	25,000,000
Russia	51,966,000	47,918,000	30,912,000	34,256,000	64,596,000
Total Europe	437,430,000	509,154,000	394,090,000	465,102,000	564,322,000
Algeria	301,000	347,000	349,000	350,000	350,000
Egypt	35,000,000	32,000,000	30,000,000	25,000,000	30,000,000
Cape Colony	2,761,000	2,061,000	2,858,000	2,000,000	2,000,000
Total Africa	38,062,000	34,408,000	33,207,000	27,350,000	32,350,000
Australasia	9,412,000	9,780,000	10,025,000	10,168,000	10,505,000
North America	2,050,302,000	2,059,713,000	2,193,938,000	2,225,254,000	1,628,141,000
South America	52,000,000	69,932,000	87,000,000	71,035,000	92,576,000
Europe	437,430,000	509,154,000	394,090,000	465,102,000	564,322,000
Africa	38,062,000	34,408,000	33,207,000	27,350,000	32,350,000
Australasia	9,412,000	9,780,000	10,025,000	10,168,000	10,505,000
Total	2,587,206,000	2,682,987,000	2,718,260,000	2,798,909,000	2,327,894,000

[a] The figures in the following tables were furnished by the Division of Statistics, Department of Agriculture, except such as otherwise credited. All prices are on gold basis.

Visible supply of corn in the United States first of each month for ten years.[a]

Month.	1893–1894.	1894–1895.	1895–1896.	1896–1897.	1897–1898.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
July	10,151,000	7,793,000	10,762,000	11,199,000	21,501,000
August	9,995,000	4,816,000	5,770,000	13,246,000	20,018,000
September	6,996,000	4,295,000	6,819,000	18,608,000	37,528,000
October	9,986,000	5,206,000	6,760,000	17,800,000	45,412,000
November	11,318,000	3,353,000	6,338,000	23,913,000	52,980,000
December	9,412,000	6,380,000	7,381,000	22,635,000	49,559,000
January	11,335,000	12,882,000	9,164,000	26,457,000	48,292,000
February	19,183,000	16,733,000	17,035,000	29,725,000	53,522,000
March	22,758,000	17,001,000	17,040,000	33,764,000	52,457,000
April	21,362,000	16,330,000	19,290,000	32,670,000	52,228,000
May	14,881,000	11,602,000	13,239,000	21,707,000	34,734,000
June	9,555,000	12,629,000	11,231,000	16,161,000	28,288,000
Month.	**1898–1899.**	**1899–1900.**	**1900–1901.**	**1901–1902.**	**1902–1903.**
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
July	32,983,000	21,551,000	19,087,000	21,522,000	8,541,000
August	25,430,000	17,687,000	18,613,000	19,648,000	9,013,000
September	24,043,000	11,070,000	8,766,000	19,476,000	3,823,000
October	30,132,000	16,662,000	11,106,000	21,215,000	4,607,000
November	33,198,000	18,738,000	11,061,000	19,137,000	4,229,000
December	25,870,000	17,555,000	12,791,000	16,599,000	4,552,000
January	26,936,000	19,024,000	14,313,000	16,825,000	9,345,000
February	36,726,000	20,110,000	21,950,000	17,197,000	11,535,000
March	44,792,000	28,340,000	27,538,000	15,270,000	15,180,000
April	43,618,000	31,883,000	28,947,000	13,540,000	16,901,000
May	34,236,000	30,416,000	24,544,000	9,093,000	9,454,000
June	19,070,000	18,289,000	21,904,000	6,317,000	....

[a] These figures represent stocks available at 62 of the principal points of accumulation east of the Rocky Mountains, stocks in Manitoba elevators, and stocks afloat on lakes and canals, as reported by Bradstreet's.

Condition of the corn crop of the United States, monthly, 1888–1902.

Year.	July.	Aug.	Sept.	Oct.	Year.	July.	Aug.	Sept.	Oct.	Year.	July.	Aug.	Sept.	Oct.
1888	93.0	95.5	94.2	92.0	1893	93.2	87.0	76.7	75.1	1898	90.5	87.0	84.1	82.0
1889	90.3	94.8	90.9	91.7	1894	95.0	69.1	63.4	64.2	1899	86.5	89.9	85.2	82.7
1890	93.1	73.3	70.1	70.6	1895	99.3	102.5	96.4	95.5	1900	89.5	87.5	80.6	78.2
1891	92.8	90.8	91.1	92.5	1896	92.4	96.0	91.0	90.5	1901	81.3	54.0	51.7	52.1
1892	81.1	82.5	79.6	79.8	1897	82.9	84.2	79.3	77.1	1902	87.5	86.5	84.3	79.6

Acreage, production, value, prices, and exports of corn of the United States, 1866–1902.

Year.	Acreage.	Average yield per acre.	Production.	Average farm price per bushel, Dec. 1.	Farm value, Dec. 1.	Chicago cash price per bushel, No. 2.				Domestic exports, including corn meal, fiscal years beginning July 1.
						December.		May of following year.		
						Low.	High.	Low.	High.	
	Acres.	*Bush.*	*Bushels.*	*Cents.*	*Dollars.*	*Cts.*	*Cts.*	*Cts.*	*Cts.*	*Bushels.*
1866	34,306,538	25.3	867,946,295	47.4	411,450,830	53	62	64	79	16,026,947
1867	32,520,249	23.6	768,320,000	57.0	437,769,763	61	65	61	71	12,493,522
1868	34,887,246	26.0	906,527,000	46.8	424,056,649	38	58	44	51	8,286,665
1869	37,103,245	23.6	874,320,000	59.8	522,550,509	56	67	73	85	2,140,487
1870	38,646,977	28.3	1,094,255,000	49.4	540,520,456	41	59	46	52	10,676,873
1871	34,091,137	29.1	991,898,000	43.4	430,355,910	36	39	38	43	35,727,010
1872	35,526,836	30.8	1,092,719,000	35.3	385,736,210	27	28	34	39	40,154,374
1873	39,197,148	23.8	932,274,000	44.2	411,961,151	40	49	49	59	35,985,834
1874	41,036,918	20.7	850,148,500	58.4	496,271,255	64	76	53	67	30,025,036
1875	44,841,371	29.5	1,321,069,000	36.7	484,674,804	40	47	41	45	50,910,532
1876	49,033,364	26.2	1,283,827,500	34.0	436,108,521	40	43	43	56	72,652,611
1877	50,369,113	26.7	1,342,558,000	34.8	467,635,230	41	49	35	41	87,192,110
1878	51,585,000	26.9	1,388,218,750	31.7	440,280,517	30	32	33	36	87,884,892
1879	53,085,450	29.2	1,547,901,790	37.5	580,486,217	39	43¼	32⅞	36⅛	99,572,329

Acreage, production, value, prices, and exports of corn of the United States, 1866–1902—Continued.

Year.	Acreage.	Average yield per acre.	Production.	Average farm price per bushel, Dec. 1.	Farm value, Dec. 1.	Chicago cash price per bushel, No. 2. December. Low.	December. High.	May of following year. Low.	May of following year. High.	Domestic exports, including corn meal, fiscal years beginning July 1.
	Acres.	*Bush.*	*Bushels.*	*Cents.*	*Dollars.*	*Cts.*	*Cts.*	*Cts.*	*Cts.*	*Bushels.*
1880	62, 317, 842	27. 6	1, 717, 434, 543	39. 6	679, 714, 499	35⅝	42	41½	45	93, 648, 147
1881	64, 262, 025	18. 6	1, 194, 916, 000	63. 6	759, 482, 170	58½	63½	69	76⅞	44, 340, 683
1882	65, 659, 545	24. 6	1, 617, 025, 100	48. 5	783, 867, 175	49¼	61	53¼	56¾	41, 655, 653
1883	68, 301, 889	22. 7	1, 551, 066, 895	42. 4	658, 051, 485	54¼	63⅛	52½	57	46, 258, 606
1884	69, 683, 780	25. 8	1, 795, 528, 000	35. 7	640, 735, 560	34½	40¼	44¾	49	52, 876, 456
1885	73, 130, 150	26. 5	1, 936, 176, 000	32. 8	635, 674, 630	36	42¾	34¼	36¾	64, 829, 617
1886	75, 694, 208	22. 0	1, 665, 441, 000	36. 6	610, 311, 000	35¾	38	36⅞	39⅜	41, 368, 584
1887	72, 392, 720	20. 1	1, 456, 161, 000	44. 4	646, 106, 770	47	51⅛	54	60	25, 360, 869
1888	75, 672, 763	26. 3	1, 987, 790, 000	34. 1	677, 561, 580	33½	35⅞	33⅛	35⅜	70, 841, 673
1889	78, 319, 651	27. 0	2, 112, 892, 000	28. 3	597, 918, 829	29¼	35	32¾	35	103, 418, 709
1890	71, 970, 763	20. 7	1, 489, 970, 000	50. 6	754, 433, 451	47¾	53	55	69½	32, 041, 529
1891	76, 204, 515	27. 0	2, 060, 154, 000	40. 6	836, 439, 228	39⅜	59	40¾	*a*100	76, 602, 285
1892	70, 626, 658	23. 1	1, 628, 464, 000	39. 4	642, 146, 630	40	42⅞	39½	44½	47, 121, 894
1893	72, 036, 465	22. 5	1, 619, 496, 131	36. 5	591, 625, 627	34¼	36½	36¾	38½	66, 489, 529
1894	62, 582, 269	19. 4	1, 212, 770, 052	45. 7	554, 719, 162	44¾	47½	47¾	55½	28, 585, 405
1895	82, 075, 830	26. 2	2, 151, 138, 580	25. 3	544, 985, 534	25	26¾	27½	29½	101, 100, 375
1896	81, 027, 156	28. 2	2, 283, 875, 165	21. 5	491, 006, 967	22½	23¾	23	25½	178, 817, 417
1897	80, 095, 051	23. 8	1, 902, 967, 933	26. 3	501, 072, 952	25	27½	32⅜	37	212, 055, 543
1898	77, 721, 781	24. 8	1, 924, 184, 660	28. 7	552, 023, 428	33⅛	38	32½	34⅜	177, 255, 046
1899	82, 108, 587	25. 3	2, 078, 143, 933	30. 3	629, 210, 110	30	31½	36	40½	213, 123, 412
1900	83, 320, 872	25. 3	2, 105, 102, 516	35. 7	751, 220, 034	35¼	40½	42⅝	58½	181, 405, 473
1901	91, 349, 928	16. 7	1, 522, 519, 891	60. 5	921, 555, 768	62½	66⅜	59⅛	64¾	28, 028, 688
1902	94, 034, 613	26. 8	2, 523, 648, 312	40. 3	1,017,017,349	43¾	57¼	......	......	....

a Coincident with "corner."

Acreage, production, value, and distribution of corn of the United States, in 1902, by States.

States and Territories.	Crop of 1902. Acreage.	Crop of 1902. Production.	Crop of 1902. Value.	Stock on hand Mar. 1, 1903.	Stock on hand Mar. 1, 1903.	Shipped out of county where grown.
	Acres.	*Bushels.*	*Dollars.*	*Bushels.*	*Per cent.*	*Bushels.*
Maine	14, 063	305, 167	225, 824	54, 930	18	....
New Hampshire	28, 761	670, 131	489, 196	187, 637	28	....
Vermont	57, 718	1, 258, 252	855, 611	377, 476	30	....
Massachusetts	46, 670	1, 460, 771	1, 080, 971	423, 624	29	....
Rhode Island	10, 322	293, 145	228, 653	123, 121	42	....
Connecticut	52, 434	1, 651, 671	1, 222, 237	512, 018	31	66, 067
New York	645, 230	16, 130, 750	10, 807, 602	4, 677, 918	29	161, 308
New Jersey	292, 770	10, 100, 565	5, 656, 316	4, 747, 266	47	1, 010, 057
Pennsylvania	1, 486, 383	53, 658, 426	31, 121, 887	21, 999, 955	41	2, 146, 337
Delaware	187, 134	5, 239, 752	2, 567. 478	2, 095, 901	40	2, 148, 298
Maryland	628, 982	20, 379, 017	10, 393, 299	8, 355, 397	41	5, 909, 915
Virginia	1, 879, 348	41, 345, 656	21, 499, 741	17, 365, 176	42	3, 721, 109
North Carolina	2, 706, 682	37, 622, 880	22, 573, 728	16, 177, 838	43	1, 881, 144
South Carolina	1, 825, 837	18, 988, 705	13, 102, 206	8, 544, 917	45	379, 774
Georgia	3, 899, 331	35, 093, 979	25, 618, 605	14, 388, 531	41	1, 403, 759
Florida	602, 400	5, 180, 640	3, 989, 093	1, 813, 224	35	155, 419
Alabama	2, 764, 717	23, 223, 623	15, 559, 827	6, 967, 087	30	696, 709
Mississippi	2, 144, 225	24, 658, 588	15, 041, 739	8, 877, 092	36	493, 172
Louisiana	1, 342, 781	16, 784, 762	11, 077, 943	4, 699, 733	28	167, 848
Texas	5, 539, 187	44, 867, 415	29, 612, 494	5, 384, 090	12	1, 346, 022
Arkansas	2, 378, 171	50, 655, 042	24, 820, 971	22, 288, 218	44	3, 039, 303
Tennessee	3, 337, 047	73, 081, 329	34, 348, 225	27, 770, 905	38	9, 500, 573
West Virginia	774, 061	20, 512, 616	11, 076, 813	7, 384, 542	36	1, 025, 631
Kentucky	3, 336, 791	90, 093, 357	37, 839, 210	37, 839, 210	42	9, 009, 336
Ohio	3, 200, 224	121, 608, 512	51, 075, 575	48, 643, 405	40	26, 753, 873
Michigan	1, 333, 099	35, 193, 814	18, 300, 783	10, 206, 206	29	2, 463, 567
Indiana	4, 520, 637	171, 332, 142	61, 679, 571	73, 672, 821	43	53, 112, 964
Illinois	9, 623, 680	372, 436, 416	134, 077, 110	171, 320, 751	46	148, 974, 566
Wisconsin	1, 504, 445	42, 425, 349	21, 212, 674	12, 727, 605	30	2, 545, 521
Minnesota	1, 483, 621	33, 826, 559	13, 530, 624	10, 147, 968	30	4, 735, 718
Iowa	9, 302, 688	297, 686, 016	98, 236, 385	107, 166, 966	36	32, 745, 462
Missouri	6, 775, 195	264, 232, 605	87, 196, 760	137, 400, 955	52	60, 773, 499
Kansas	7, 451, 693	222, 805, 621	75, 753, 911	93, 578, 361	42	66, 841, 686
Nebraska	7, 817, 962	252, 500, 173	75, 756, 052	128, 785, 288	51	98, 482, 867
South Dakota	1, 577, 398	29, 812, 822	12, 223, 257	7, 155, 077	24	2, 086, 898
North Dakota	82, 700	1, 604, 380	721, 971	369, 007	23	48, 131
Montana	3, 714	81, 708	58, 830	8, 988	11	817

Acreage, production, value, and distribution of corn of the United States, in 1902, by States—Continued.

States and Territories.	Crop of 1902. Acreage.	Crop of 1902. Production.	Crop of 1902. Value.	Stock on hand Mar. 1, 1903.	Stock on hand Mar. 1, 1903.	Shipped out of county where grown.
	Acres.	*Bushels.*	*Dollars.*	*Bushels.*	*Per cent.*	*Bushels.*
Wyoming	2,384	47,203	27,850	4,248	9	....
Colorado	115,697	1,909,000	1,126,310	439,070	23	38,180
New Mexico	36,909	811,998	633,358	40,600	5	32,480
Arizona	7,502	151,540	153,055	7,577	5	1,515
Utah	10,810	217,281	145,578	17,382	8	....
Idaho	5,142	127,007	78,744	7,620	6	....
Washington	10,014	230,322	149,709	9,213	4	23,032
Oregon	17,045	398,853	263,243	27,920	7	15,954
California	60,300	1,839,150	1,416,146	202,306	11	220,698
Oklahoma	1,569,831	40,501,640	15,795,640	12,150,492	30	8,505,344
Indian Territory	1,549,878	38,591,962	16,594,544	13,507,187	35	4,631,035
United States	94,013,613	2,523,648,312	1,017,017,349	1,050,652,819	41.6	557,295,588

Average yield per acre of corn in the United States, 1893–1902, by States.

States and Territories.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.
	Bush.	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*
Maine	30.3	39.9	42.0	37.0	37.0	40.0	36.0	36.0	39.4	21.7
New Hampshire	31.7	34.3	40.2	42.0	34.0	41.0	39.0	37.0	38.5	23.3
Vermont	32.4	40.8	45.6	41.0	35.0	43.0	36.0	40.0	40.0	21.8
Massachusetts	33.5	34.5	43.9	43.0	32.5	40.0	36.0	38.0	40.5	31.3
Rhode Island	24.4	31.4	30.9	34.0	31.0	34.0	31.0	32.0	32.1	28.4
Connecticut	28.2	31.0	37.9	38.0	31.5	37.0	39.0	38.0	39.0	31.5
New York	29.5	28.2	35.6	34.0	31.0	33.0	31.0	32.0	33.0	25.0
New Jersey	25.9	33.1	33.0	33.0	31.5	37.0	39.0	33.0	36.9	34.5
Pennsylvania	24.5	32.0	33.5	40.0	36.0	37.0	32.0	25.0	35.0	36.1
Delaware	24.6	22.0	21.0	22.0	29.0	25.0	22.0	24.0	30.0	28.0
Maryland	24.2	22.9	26.8	32.0	33.0	31.0	32.0	26.0	34.2	32.4
Virginia	18.9	19.1	18.6	21.5	18.0	22.0	20.0	16.0	22.2	22.0
North Carolina	12.3	13.4	14.5	12.0	13.0	14.0	13.0	12.0	12.0	13.9
South Carolina	7.7	11.2	11.1	9.0	9.0	10.0	9.0	7.0	6.9	10.4
Georgia	11.1	11.7	13.0	11.0	11.0	9.0	10.0	10.0	10.0	9.0
Florida	9.7	10.1	11.2	10.0	8.0	9.0	10.0	8.0	9.0	8.6
Alabama	11.5	13.7	15.9	12.5	12.0	15.0	12.0	11.0	10.9	8.4
Mississippi	13.1	17.2	15.8	13.5	14.5	18.0	16.0	11.0	10.9	11.5
Louisiana	14.2	16.2	18.8	13.0	17.0	18.0	18.0	17.0	13.7	12.5
Texas	17.6	19.0	26.4	9.5	18.5	25.0	18.0	18.0	11.6	8.1
Arkansas	16.2	19.2	21.5	13.5	16.0	20.0	20.0	19.0	8.1	21.3
Tennessee	21.3	21.9	25.0	23.0	21.0	26.0	20.0	20.0	14.2	21.9
West Virginia	21.7	18.5	24.2	30.0	24.5	29.0	26.0	27.0	23.0	26.5
Kentucky	23.5	23.0	31.2	28.0	23.0	31.0	21.0	26.0	15.6	27.0
Ohio	23.8	26.3	32.6	41.0	32.5	37.0	36.0	37.0	26.1	38.0
Michigan	23.7	23.2	33.8	38.0	31.5	34.0	25.0	36.0	34.5	26.4
Indiana	24.7	28.9	32.8	35.0	30.0	36.0	38.0	38.0	19.8	37.9
Illinois	25.7	28.8	37.4	40.5	32.5	30.0	36.0	37.0	21.4	38.7
Wisconsin	29.8	20.7	31.8	37.0	33.0	35.0	35.0	40.0	27.4	28.2
Minnesota	28.3	18.4	31.2	30.5	26.0	32.0	33.0	33.0	26.3	22.8
Iowa	33.9	15.0	35.1	39.0	29.0	35.0	31.0	38.0	25.0	32.0
Missouri	27.9	22.0	36.0	27.0	26.0	26.0	26.0	28.0	10.1	39.0
Kansas	21.3	11.2	24.3	28.0	18.0	16.0	27.0	19.0	7.8	29.9
Nebraska	25.2	6.0	16.1	37.5	30.0	21.0	28.0	26.0	14.1	32.3
South Dakota	23.7	4.2	11.1	26.0	24.0	28.0	26.0	27.0	21.0	18.9
North Dakota	20.7	19.2	21.3	35.0	17.0	19.0	23.0	16.0	22.6	19.4
Montana	27.5	32.7	25.0	26.0	18.0	28.0	23.0	15.0	25.0	22.0
Wyoming	18.5	30.0	27.5	25.0	12.0	16.0	22.0	34.0	39.5	19.8
Colorado	16.5	19.7	20.7	16.0	19.0	18.0	17.0	19.0	17.1	16.5
New Mexico	25.3	19.1	27.2	16.0	27.0	21.0	20.0	22.0	31.6	22.0
Arizona	......	......	......	......	......	......	......	......	18.0	20.2
Utah	21.5	24.4	20.3	25.0	22.0	21.0	20.0	20.0	19.4	20.1
Idaho	......	......	......	......	......	......	......	......	23.0	24.7
Washington	21.3	20.8	17.1	14.0	18.0	12.0	23.0	20.0	17.5	23.0
Oregon	24.7	25.4	26.4	22.0	25.0	24.0	22.0	23.0	20.8	23.4
California	31.7	19.3	34.5	37.0	31.5	26.0	27.0	25.0	31.0	30.5
Oklahoma	......	......	......	......	......	......	19.0	26.0	7.3	25.8
Indian Territory	......	......	......	......	......	......	......	......	12.0	24.9
General average	22.5	19.4	26.2	28.2	23.8	24.8	25.3	25.3	16.7	26.8

Average value per acre of corn in the United States, based upon farm value December 1, 1893–1902, by States.

States and Territories.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.
Maine	$18.79	$28.73	$22.68	$17.39	$17.39	$19.20	$18.00	$19.80	$29.94	$16.06
New Hampshire	18.07	26.07	20.50	18.90	15.30	18.86	19.11	20.72	30.03	17.01
Vermont	19.76	28.15	21.89	15.58	15.05	18.92	16.92	20.00	29.20	14.82
Massachusetts	20.77	21.05	22.83	19.78	15.28	19.60	18.36	20.52	30.78	23.16
Rhode Island	16.84	23.55	17.30	16.66	16.74	21.76	16.43	21.44	24.40	22.15
Connecticut	18.05	21.08	19.33	15.96	15.43	19.24	19.50	20.90	29.25	23.31
New York	16.23	17.20	16.02	12.92	12.40	14.19	13.95	15.04	23.76	16.75
New Jersey	13.47	17.87	13.86	11.88	11.97	14.80	15.60	14.85	24.35	19.32
Pennsylvania	12.00	17.69	13.07	13.20	22.24	14.80	13.12	11.25	21.70	20.94
Delaware	9.84	9.90	7.14	5.50	8.70	7.75	7.48	9.12	17.10	13.72
Maryland	10.64	11.45	9.92	10.24	9.90	10.85	11.52	10.66	19.84	16.52
Virginia	8.69	8.98	6.88	6.88	6.84	7.70	7.60	7.84	13.10	11.44
North Carolina	6.15	6.30	5.51	4.44	5.59	6.02	6.11	6.84	8.76	8.34
South Carolina	4.62	7.28	5.11	4.14	4.41	4.60	4.50	4.48	5.80	7.18
Georgia	6.22	6.79	5.33	4.73	5.28	4.32	5.00	5.70	8.20	6.57
Florida	6.60	7.17	5.26	5.30	4.40	4.50	5.30	4.80	7.65	6.62
Alabama	6.79	7.26	5.88	5.63	5.52	6.15	5.64	6.38	8.39	5.63
Mississippi	7.20	8.43	5.85	5.94	6.53	7.02	7.36	6.38	8.07	7.02
Louisiana	8.09	10.04	7.24	5.85	7.65	7.38	7.92	8.50	10.27	8.25
Texas	9.50	10.64	8.18	3.90	7.58	8.50	6.48	8.46	9.28	5.35
Arkansas	7.29	9.02	6.88	4.99	6.40	5.80	7.60	8.17	6.56	10.44
Tennessee	8.31	8.54	6.75	6.44	7.56	7.54	7.80	9.80	9.23	10.29
West Virginia	11.94	10.55	9.68	10.20	9.80	10.73	11.70	13.50	14.95	14.31
Kentucky	10.11	10.12	8.42	7.00	8.05	8.37	7.77	10.40	9.52	11.34
Ohio	9.52	11.31	8.80	8.61	8.12	9.99	10.80	12.58	14.88	15.96
Michigan	10.66	11.60	10.82	9.12	8.50	11.56	9.00	13.32	17.94	13.73
Indiana	8.89	10.69	7.54	6.65	6.30	9.00	10.26	12.16	10.89	13.64
Illinois	7.97	11.23	8.23	7.29	6.83	7.50	9.36	11.84	12.20	13.93
Wisconsin	10.43	9.32	9.54	8.14	8.25	9.80	10.50	13.20	14.25	14.10
Minnesota	9.62	7.91	6.24	5.79	6.24	7.68	7.92	9.57	11.83	9.12
Iowa	9.15	6.75	6.32	5.46	4.93	8.05	7.13	10.26	13.00	10.56
Missouri	8.37	8.80	7.20	5.40	6.24	7.02	7.80	8.96	6.77	12.87
Kansas	6.60	4.82	4.62	5.04	3.96	4.16	6.75	6.08	4.91	10.17
Nebraska	6.80	3.00	2.90	4.88	5.10	4.62	6.44	8.06	7.61	9.69
South Dakota	5.93	1.93	2.55	4.68	5.04	6.44	6.76	7.83	9.45	7.75
North Dakota	7.87	8.45	5.11	8.75	5.44	6.84	7.59	6.72	10.40	8.73
Montana	19.25	26.81	18.75	15.60	11.70	18.48	11.96	8.85	22.50	15.84
Wyoming	11.66	19.50	15.67	19.50	6.00	8.80	9.46	20.40	28.44	11.68
Colorado	8.42	12.02	8.49	5.76	7.22	7.20	7.31	9.12	12.65	9.73
New Mexico	17.96	14.33	15.23	8.80	15.66	11.76	11.60	14.08	24.33	17.16
Arizona	......	......	......	......	......	......	......	......	16.20	20.40
Utah	12.47	14.15	9.95	12.75	12.10	12.60	11.80	12.60	17.46	13.47
Idaho	......	......	......	......	......	......	......	......	13.80	15.31
Washington	13.21	14.35	6.84	7.98	9.90	5.04	12.65	11.80	10.15	14.95
Oregon	11.61	14.22	14.52	12.32	13.25	14.40	14.08	13.11	11.86	15.44
California	15.85	11.00	18.29	19.61	17.64	16.12	16.20	15.25	21.08	23.49
Oklahoma	......	......	......	......	......	......	3.80	6.76	5.55	10.06
Indian Territory	......	......	......	......	......	......	......	......	9.12	10.71
General average	8.21	8.86	6.64	6.06	6.26	7.10	7.66	9.02	10.09	10.81

Average farm price of corn per bushel in the United States, December 1, 1893–1902, by States.

States and Territories.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
Maine	62	72	54	47	47	48	50	55	76	74
New Hampshire	57	76	51	45	45	46	49	56	78	73
Vermont	61	69	48	38	43	44	47	50	73	68
Massachusetts	62	61	52	46	47	49	51	54	76	74
Rhode Island	69	75	56	49	54	64	53	67	76	78
Connecticut	64	68	51	42	49	52	50	55	75	74
New York	55	61	45	38	40	43	45	47	72	67
New Jersey	52	54	42	36	38	40	40	45	66	56
Pennsylvania	49	55	39	33	34	40	41	45	62	58
Delaware	40	45	34	25	30	31	34	38	57	49
Maryland	44	50	37	32	30	35	36	41	58	51
Virginia	46	47	37	32	38	35	38	49	59	52
North Carolina	50	47	38	37	43	43	47	57	73	60
South Carolina	60	65	46	46	49	46	50	64	84	69
Georgia	56	58	41	43	48	48	50	57	82	73
Florida	68	71	47	53	55	50	53	60	85	77
Alabama	59	53	37	45	46	41	47	58	77	67
Mississippi	55	49	37	44	45	39	46	58	74	61
Louisiana	57	62	40	45	45	41	44	50	75	66
Texas	54	56	31	41	41	34	36	47	80	66

Average farm price of corn per bushel in the United States, December 1, 1893–1902, by States—Continued.

States and Territories.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
Arkansas	45	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	38	[illegible]	[illegible]	49
Tennessee	33	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	39	[illegible]	[illegible]	47
West Virginia	55	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	45	[illegible]	[illegible]	54
Kentucky	43	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	37	[illegible]	[illegible]	42
Ohio	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	30	[illegible]	[illegible]	42
Michigan	45	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	36	[illegible]	[illegible]	52
Indiana	36	[illegible]	[illegible]	[illegible]	21	[illegible]	27	[illegible]	[illegible]	36
Illinois	31	[illegible]	[illegible]	[illegible]	21	[illegible]	26	[illegible]	[illegible]	36
Wisconsin	35	[illegible]	[illegible]	[illegible]	25	[illegible]	30	[illegible]	[illegible]	50
Minnesota	34	[illegible]	[illegible]	[illegible]	24	[illegible]	24	[illegible]	[illegible]	40
Iowa	27	[illegible]	[illegible]	14	17	[illegible]	26	[illegible]	[illegible]	33
Missouri	30	[illegible]	[illegible]	[illegible]	24	[illegible]	30	[illegible]	[illegible]	33
Kansas	31	[illegible]	[illegible]	[illegible]	22	[illegible]	25	[illegible]	[illegible]	34
Nebraska	27	[illegible]	[illegible]	[illegible]	17	[illegible]	23	[illegible]	54	30
South Dakota	25	[illegible]	[illegible]	[illegible]	21	[illegible]	26	[illegible]	[illegible]	41
North Dakota	38	[illegible]	[illegible]	[illegible]	32	[illegible]	33	[illegible]	[illegible]	45
Montana	70	[illegible]	[illegible]	[illegible]	65	[illegible]	52	[illegible]	[illegible]	72
Wyoming	63	[illegible]	[illegible]	[illegible]	50	[illegible]	43	[illegible]	[illegible]	59
Colorado	51	[illegible]	41	[illegible]	38	[illegible]	43	[illegible]	74	59
New Mexico	71	[illegible]	[illegible]	[illegible]	58	[illegible]	58	[illegible]	[illegible]	78
Arizona	......	......	......	......	......	......	......	......	[illegible]	101
Utah	[illegible]	[illegible]	41	51	[illegible]	[illegible]	59	[illegible]	[illegible]	67
Idaho	......	......	......	......	......	......	......	......	[illegible]	62
Washington	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	41	55	[illegible]	[illegible]	65
Oregon	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	64	[illegible]	[illegible]	66
California	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	42	60	[illegible]	[illegible]	77
Oklahoma	......	......	......	......	......	......	20	[illegible]	[illegible]	39
Indian Territory	......	......	......	......	......	......	......	......	[illegible]	43
General average	36.5	45.7	25.3	21.5	26.3	28.7	30.3	35.7	60.5	40.3

Transportation rates, average for corn, in cents, St. Louis to New Orleans by river.

Year.	Per bushel.		Year.	Per bushel.		Sacks per 100 lbs.	Year.	Per bushel.		Sacks per 100 lbs.	Year.	Sacks per 100 lbs.
	Low water.	High water.		Low water.	High water.			Low water.	High water.			
[illegible]	11.[illegible]	[illegible]	[illegible]	[illegible]	11.[illegible]	......	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	20.04	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	20.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	7.00	20.00	1891	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	7.00	17.75	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	7.00	14.[illegible]	1893	......	......	[illegible]	[illegible]	20.00

VALUE OF GOOD SEED CORN.

It is estimated that the production of corn in this country could be nearly doubled by the use of the best varieties of corn for seed, selected by scientific methods and cultivated thoroughly well. If this increase can be made only 10 per cent, the annual addition to the production of wealth in the United States would be from $75,000,000 to $100,000,000.

Wholesale prices of corn per bushel in leading cities of the United States, 1897–1902.

Date.	New York.		Baltimore.		Cincinnati.		Chicago.		Detroit.		St. Louis.		San Francisco.	
	No. 2.		No. 2.		No. 2.		No. 2.		No. 2.		No. 2.		No. 1, white (per cwt).	
	Low.	High.	Low.	High.	Low.	High.	Low.	High.	Low.	High.	Low.	High.	Low.	High.
1897.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*		
January	28¼	29¾	22	28¼	22½	24	21¾	23⅜	21½	23	19¼	20¾	$0.77½	$0.87½
February	28	29⅜	26	29	23½	25	21¾	23¼	21½	23½	19½	20½	.77½	.82½
March	27	30½	26½	31	24	25½	22¾	24½	23	25	20⅛	21½	.80	.85
April	28¾	30¾	28½	31	25	30	23⅛	25¼	24	26	20½	22¾	.81¼	.85
May	29	30⅞	31	34	26½	31	23	25½	23	27	20⅜	24	.82½	.97½
June	28½	30	30	33	26	27½	23¼	25⅝	24	27	21½	23½	.90	.97½
July	28½	33⅜	30	35	27½	29½	24⅜	28¼	26½	28½	21½	25½	.90	.97½
August	31¼	38	34	38	28¾	33	26⅛	32⅝	28½	32½	25	27¾	1.05	1.10
September	32	37½	36	39	30½	33½	27¼	32	30	32½	25	29½	1.07½	1.12½
October	29⅜	33½	31	37½	26½	31	24	29	24½	31	24	27½	1.10	1.12½
November	30⅝	32¾	30	35½	26	28½	25¾	27⅜	25¾	26⅛	24⅜	26⅛	.90	.97½
December	31¼	34	27½	35½	27	30	25	27½	26½	30½	24	26¼	.90	.92½
1898.														
January	33	35½	29	35¾	29	30	26	28¼	28½	30	25¼	26¾	.85	.97½
February	34¼	37¼	32	36	29½	32	27¼	30⅝	28¾	33½	26	28½	.97½	1.10
March	34¼	36¼	32½	35	31⅝	32¼	28⅛	29¾	29½	32	26½	27⅞	1.05	1.12½
April	34⅜	40⅝	34	42	31½	38	28⅞	35¼	31	36½	27	32¾	1.10	1.15
May	36¾	41⅞	36¾	42½	37	40	32⅜	37	35	39½	32	35½	1.10	1.12½
June	35⅛	38⅝	35½	37½	34¼	36	31	33¾	31¾	36	30	32½	1.05	1.12½
July	35½	38¾	35	42	34½	37½	31¾	35½	32	36	30½	33¾	1.07½	1.12½
August	35	38	33	41	31	36½	29¾	33¾	32	35½	28¼	33	1.10	1.17½
September	34	35½	34	36½	31	31½	29⅛	31⅜	30½	32½	28½	29⅝	1.12½	1.15
October	34¼	38¾	34	38	31	35	28¾	32⅞	30	35½	29	32½	1.05	1.15
November	37½	39¼	32	39	34	37	31⅝	34½	34	36	30	32½	1.05	1.07½
December	38⅞	44¼	36	43½	34	38½	33⅛	38	34	38	31¾	36¼	1.05	1.15
1899.														
January	41⅜	45⅝	39½	41⅝	35½	38	35¼	38⅛	37	38	34¾	36¼	1.12	1.15
February	42¼	45	37¾	42	33	37	33½	37	35½	37	33	35	Nominal.	
March	41	45⅛	36	39⅜	35	37½	33	36⅛	34½	36½	33	34¾	Nominal.	
April	41	45½	38	43	36½	37½	34	35½	35½	37½	33½	35	1.15	1.17½
May	39¼	43½	36¾	38¾	34	36½	32½	34⅜	34½	35½	31½	34½	1.17½	1.17½
June	40⅛	42⅝	37	39½	35	36½	33¼	35½	34½	35	32	33½	1.15	1.17½
July	37⅜	41½	35	38¾	35	36½	31	34⅞	34	35½	31½	33½	1.15	1.15
August	36½	41¼	34¾	37½	32	34½	30½	33	33½	35	30	31½	1.07½	1.12½
September	38⅝	41⅝	36½	40½	33¾	35	31¼	35	33¼	35½	30	31	1.07½	1.07½
October	39¾	42⅜	37½	39¼	34	36	31	33	31½	36½	30½	31¾	Nominal.	
November	39⅝	41¾	37½	39¾	31½	35	30¾	33¼	33	35½	30	31½	Nominal.	
December	39⅞	40⅝	36⅜	38⅜	31½	31	30	31½	32	33½	29½	31	1.05	1.05

	Mixed.													
1900.														
January	39⅞	42¼	36⅝	37¾	32¾	36	30½	31⅛	32½	34	30½	31	1.00	1.00
February	39⅞	41⅛	36¾	40⅜	33¼	36	31½	34¼	33½	35½	30½	33½	1.00	1.00
March	40⅞	46	38	42⅞	36	40¾	33⅜	38¼	36	40½	33½	37½	1.02½	1.10
April	45¾	49¾	42⅝	45½	41	43½	38¼	40⅞	40	43½	37½	39¾	1.07½	1.10
May	41	47⅛	40⅝	45	40½	44	36	40½	39¼	41	36⅝	40½	1.02½	1.07½
June	42¾	50⅝	41⅝	48	39¾	45	37⅜	43½	39¾	45	37	42	1.02½	1.17½
July	44	52⅛	42⅜	48¾	41½	47	38⅜	44¾	40¾	45	37½	43	1.17½	1.17½
August	42⅞	47¾	41¾	45	41	43	37¼	41¼	42½	43¾	37½	40	1.22½	1.30
September	45	50⅜	44¼	47	42½	44	38⅞	43¼	43½	44	38¾	40½	Nominal.	
October	46	49¾	42	47	37	43	36½	41¾	41	43½	34	39	1.25	1.27½
November	45¾	47½	42¼	44½	37	40	35	49½	38¾	41	34¼	35¾	1.20	1.25
December	44¾	48	41⅞	44¼	37¾	39½	35¼	40½	38	39½	33¾	36	1.20	1.20
1901.														
January	45½	48½	41½	43¼	38	40	36	37¾	38	39½	35	37	1.12½	1.15
February	47½	49	42¼	45	39½	42¼	37¼	40	39¼	40½	37½	40	1.10	1.20
March	48¼	50½	44¼	48¼	41½	42¾	39	44	40	43	38¾	43	1.15	1.32½
April	48½	53¾	46⅛	49¾	44½	47	41	48	43	45½	41	46¼	1.15	1.35
May	49	56	46¾	50¼	43¼	46½	42⅝	58½	42¼	46	42	45⅝	1.20	1.35
June	46¼	49¾	44⅛	47¾	43½	44½	41	44⅜	42	45	41¼	44	1.25	1.37½
July	50⅛	61¼	46¼	59	45	58	43½	58¼	44½	56½	43¾	60½	1.50	1.75
August	60	64	56½	63½	57½	64	53¾	59½	37	39½	55¼	63	1.65	1.70
September	61½	66⅛	59¼	62	56½	61½	54⅛	59¾	55¾	59½	55¾	60	1.55	1.65
October	60⅞	64	58¼	61	60	60½	54⅝	58	57½	60	57	61	1.62½	1.70
November	63½	69½	60¾	67	63	66	57⅛	63⅞	60	66½	60½	66½	1.40	1.60
December	69¼	72⅞	65	68	66½	71½	62½	67½	66½	70½	65½	70	1.30	1.40
1902.														
January	66	72¼	58½	69½	62	68½	56½	61½	57	67¾	59	69¼	1.30	1.45
February	66½	71¼	60¼	68½	61	64½	56⅝	61¼	59	62	58½	63	1.35	1.45
March	65	71½	63	68	62	64	56	61½	59	61½	59	63	1.35	1.42½
April	65½	73	63½	69	60½	67½	56¾	64½	59½	64½	59¾	67	1.40	1.45
May	66⅞	73	66½	70	64	67¼	59⅛	64¾	63½	65½	62½	66	1.55	1.60
June	68¾	71½	67½	72	63½	66½	61	71½	63¼	66½	62	67	1.55	1.65
July	65¾	73	67	77	63½	69	56	88	66	67	61	66	1.52½	1.60
August	63½	69½	59	67	58	64	54	60	66	67	54	61½	1.45	1.60
September	67½	72½	64	69	60	63½	57	62½	55¾	59½	56½	60½	1.45	1.65
October	67½	70½	65	69	60	62½	55	61½	57½	60	56	58½	1.45	1.60
November	61½	67	47	68	45	60	52	58	60	66½	44½	49	1.42½	1.60
December	57	64	43½	55¼	41	50	43¾	57¼	66½	70½	40½	49½	1.47½	1.65

Monthly average prices of corn in Chicago.[a]

[Cents per bushel.]

Month.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.
January	$48\frac{3}{4}$	$38\frac{3}{16}$	$42\frac{5}{8}$	$34\frac{7}{8}$	43	$26\frac{7}{8}$	$22\frac{9}{16}$	$27\frac{1}{8}$	$36\frac{11}{16}$	$31\frac{1}{16}$	$36\frac{7}{8}$	$60\frac{1}{2}$
February	$52\frac{3}{8}$	$40\frac{1}{8}$	42	$34\frac{11}{16}$	$42\frac{1}{2}$	$28\frac{7}{16}$	$22\frac{1}{2}$	$28\frac{7}{16}$	$35\frac{1}{4}$	$32\frac{7}{8}$	$38\frac{5}{8}$	$58\frac{15}{16}$
March	62	$39\frac{1}{16}$	$40\frac{13}{16}$	$35\frac{3}{4}$	$44\frac{3}{8}$	$28\frac{5}{8}$	$23\frac{3}{4}$	$28\frac{15}{16}$	$34\frac{9}{16}$	$35\frac{13}{16}$	$41\frac{1}{2}$	$58\frac{9}{16}$
April	$70\frac{11}{16}$	$40\frac{5}{8}$	$40\frac{3}{4}$	$37\frac{7}{8}$	$46\frac{15}{16}$	$29\frac{5}{8}$	$24\frac{3}{16}$	$32\frac{1}{16}$	$34\frac{3}{4}$	$39\frac{9}{16}$	$44\frac{1}{2}$	$60\frac{5}{8}$
May	$62\frac{1}{4}$	$70\frac{3}{8}$	42	$37\frac{5}{8}$	$51\frac{5}{8}$	$28\frac{1}{2}$	$24\frac{1}{4}$	$39\frac{11}{16}$	$33\frac{7}{16}$	$38\frac{1}{4}$	$50\frac{9}{16}$	$61\frac{15}{16}$
June	$58\frac{1}{8}$	51	$39\frac{9}{16}$	$39\frac{15}{16}$	50	$27\frac{3}{8}$	$24\frac{7}{16}$	$32\frac{3}{8}$	$34\frac{3}{8}$	$40\frac{7}{16}$	$41\frac{11}{16}$	$66\frac{1}{4}$
July	$61\frac{1}{2}$	$49\frac{5}{8}$	$38\frac{11}{16}$	$43\frac{1}{2}$	$44\frac{5}{8}$	26	$26\frac{7}{16}$	$38\frac{5}{8}$	$32\frac{15}{16}$	$41\frac{9}{16}$	$50\frac{7}{8}$	72
August	$63\frac{3}{16}$	$51\frac{13}{16}$	$38\frac{3}{16}$	$53\frac{1}{16}$	$40\frac{3}{8}$	$22\frac{3}{4}$	$29\frac{3}{8}$	$31\frac{3}{4}$	$31\frac{3}{4}$	$39\frac{1}{4}$	$56\frac{5}{8}$	57
September	$58\frac{3}{4}$	$46\frac{3}{16}$	$39\frac{7}{8}$	53	$33\frac{15}{16}$	$20\frac{7}{8}$	$29\frac{5}{8}$	$30\frac{1}{4}$	$33\frac{1}{8}$	$41\frac{1}{16}$	$56\frac{15}{16}$	$59\frac{3}{4}$
October	$55\frac{1}{4}$	$42\frac{3}{8}$	39	$50\frac{11}{16}$	$30\frac{3}{8}$	$24\frac{3}{8}$	$26\frac{1}{2}$	$30\frac{13}{16}$	32	$39\frac{1}{8}$	$56\frac{5}{16}$	$58\frac{1}{4}$
November	$63\frac{1}{2}$	$41\frac{13}{16}$	$37\frac{3}{16}$	50	$28\frac{1}{4}$	$24\frac{1}{8}$	$26\frac{11}{16}$	$33\frac{1}{16}$	32	$42\frac{1}{4}$	$60\frac{3}{4}$	55
December	$49\frac{3}{16}$	$41\frac{7}{16}$	$35\frac{3}{8}$	$46\frac{1}{8}$	$25\frac{7}{8}$	$23\frac{1}{8}$	$26\frac{1}{4}$	$35\frac{9}{16}$	$30\frac{3}{4}$	$37\frac{7}{8}$	65	$50\frac{1}{2}$
Yearly average	$58\frac{3}{4}$	$46\frac{1}{16}$	$39\frac{5}{8}$	$43\frac{1}{16}$	$40\frac{1}{8}$	$25\frac{7}{8}$	$25\frac{1}{2}$	$32\frac{3}{8}$	$33\frac{7}{16}$	$38\frac{1}{4}$	$50\frac{1}{8}$	$59\frac{15}{16}$

[a] This table exhibits average cash prices for the past twelve years. The monthly prices are the means between the lowest and highest prices for each month, and the yearly prices are the averages of the monthly averages.

WHEAT.

The wheat crop of the world for 1902 was 3,124,422,000 bushels, the largest ever produced. The crop of the United States totaled 670,063,000 bushels.

The exports of wheat, including flour, for the fiscal year ended June 30, 1902, reached 234,772,516 bushels, and surpassed the figures of any previous year. The average export price of wheat was generally well maintained, averaging about 73 cents per bushel.

Prices held steady and higher than during the past ten years, excepting the wide fluctuations in 1897 and 1898. The monthly average prices in Chicago ranged high and the yearly average was about 74⅝ cents.

Aside from the month of September, when cash wheat sold for 70 to 95 cents in Chicago, the entire year's fluctuations were confined to about 13 cents. Other leading markets ruled steady and strong.

Wheat crop of the world, 1898–1902.

Country.	1898.	1899.	1900.	1901.	1902.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
United States	675,149,000	547,304,000	522,230,000	748,460,000	670,063,000
Ontario	33,042,000	22,158,000	31,265,000	22,118,000	26,904,000
Manitoba	26,112,000	28,802,000	13,436,000	52,094,000	54,750,000
Rest of Canada	9,000,000	9,000,000	7,000,000	16,000,000	17,000,000
Total Canada	68,154,000	59,960,000	51,701,000	90,212,000	98,654,000
Mexico	8,789,000	9,287,000	12,429,000	9,000,000	12,403,000
Total North America	752,092,000	616,551,000	586,360,000	847,672,000	781,120,000
Chile	14,000,000	13,000,000	12,000,000	9,000,000	12,000,000
Argentina	53,389,000	104,977,000	101,655,000	72,181,000	56,380,000
Uruguay	6,000,000	7,164,000	6,891,000	3,664,000	7,604,000
Total South America	73,389,000	125,141,000	120,546,000	84,845,000	75,984,000
Great Britain	75,330,000	67,594,000	54,299,000	54,111,000	58,463,000
Ireland	1,856,000	1,786,000	1,682,000	1,470,000	1,602,000
Total United Kingdom	77,186,000	69,380,000	55,981,000	55,581,000	60,065,000
Norway	300,000	260,000	300,000	300,000	260,000
Sweden	4,542,000	4,430,000	5,249,000	4,310,000	4,649,000
Denmark	2,991,000	3,654,000	3,604,000	942,000	3,000,000
Netherlands	5,406,000	5,096,000	4,670,000	4,300,000	5,400,000
Belgium	13,211,000	11,319,000	13,788,000	13,872,000	14,228,000
France	363,498,000	364,414,000	326,083,000	310,938,000	352,716,000
Spain	123,865,000	100,759,000	92,424,000	117,765,000	123,440,000
Portugal	7,800,000	6,400,000	8,000,000	10,000,000	10,400,000
Italy	137,345,000	137,912,000	133,741,000	156,755,000	131,102,000
Switzerland	4,500,000	4,200,000	4,200,000	4,400,000	4,200,000
Germany	132,557,000	141,369,000	141,139,000	91,817,000	143,315,000

Wheat crop of the world, 1898–1902—Continued.

Country.	1898.	1899.	1900.	1901.	1902.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
Austria	46,890,000	50,209,000	40,929,000	44,027,000	49,655,000
Hungary	128,227,000	141,285,000	141,221,000	123,929,000	168,899,000
Croatia-Slavonia	11,408,000	9,014,000	11,035,000	10,709,000	14,000,000
Bosnia-Herzegovina	2,297,000	2,000,000	1,750,000	2,000,000	2,000,000
Total Austria-Hungary	188,822,000	202,508,000	194,935,000	180,665,000	234,554,000
Roumania	58,457,000	26,064,000	56,663,000	72,386,000	76,220,000
Bulgaria	33,993,000	21,630,000	27,000,000	24,000,000	32,000,000
Servia	11,000,000	10,000,000	8,135,000	9,000,000	8,000,000
Montenegro	220,000	200,000	220,000	200,000	200,000
Turkey in Europe	25,000,000	15,000,000	20,000,000	22,000,000	25,000,000
Greece	4,000,000	2,500,000	3,000,000	3,200,000	3,200,000
Russia proper	334,246,000	314,876,000	319,193,000	319,991,000	469,509,000
Poland	21,691,000	21,544,000	19,722,000	14,409,000	20,336,000
North Caucasus	52,251,000	57,313,000	56,948,000	67,232,000	77,069,000
Finland	159,000	143,000	150,000	150,000	100,000
Total Russia in Europe	408,347,000	393,876,000	396,013,000	401,782,000	567,014,000
Total Europe	1,603,040,000	1,520,971,000	1,495,145,000	1,484,213,000	1,798,963,000
Siberia	36,157,000	45,473,000	20,172,000	16,504,000	30,796,000
Central Asia	14,944,000	14,938,000	6,959,000	9,645,000	15,897,000
Transcaucasia	40,000,000	33,000,000	35,000,000	35,000,000	35,000,000
Total Russia in Asia	91,101,000	93,411,000	62,131,000	61,149,000	81,693,000
Turkey in Asia	44,000,000	35,200,000	30,000,000	30,000,000	35,000,000
Cyprus	2,400,000	2,000,000	2,400,000	2,000,000	1,800,000
Persia	17,600,000	16,000,000	16,000,000	15,200,000	13,600,000
British India	259,670,000	236,679,000	181,803,000	252,587,000	224,335,000
Japan	21,407,000	20,771,000	21,688,000	20,000,000	20,000,000
Total Asia	436,178,000	404,061,000	314,022,000	380,936,000	376,428,000
Algeria	27,114,000	22,282,000	23,000,000	23,000,000	27,000,000
Tunis	6,500,000	4,800,000	5,600,000	6,400,000	7,000,000
Egypt	13,000,000	13,000,000	13,000,000	12,000,000	12,000,000
Cape Colony	2,012,000	2,291,000	2,000,000	2,000,000	2,000,000
Total Africa	48,626,000	42,373,000	43,600,000	43,400,000	48,000,000
West Australia	421,000	892,000	1,018,000	799,000	963,000
South Australia	4,141,000	9,056,000	8,720,000	11,608,000	8,265,000
Queensland	1,041,000	626,000	634,000	1,232,000	1,746,000
New South Wales	10,893,000	9,569,000	14,033,000	16,683,000	15,275,000
Victoria	10,914,000	20,198,000	15,718,000	18,410,000	12,510,000
Tasmania	1,721,000	2,376,000	1,136,000	1,145,000	994,000
New Zealand	5,849,000	13,485,000	8,852,000	6,733,000	4,174,000
Total Australasia	34,980,000	56,202,000	50,111,000	56,610,000	43,927,000

RECAPITULATION BY CONTINENTS.

	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
North America	752,092,000	616,551,000	586,360,000	847,672,000	781,120,000
South America	73,389,000	125,141,000	120,546,000	84,845,000	75,984,000
Europe	1,603,040,000	1,520,971,000	1,495,145,000	1,484,213,000	1,798,963,000
Asia	436,178,000	404,061,000	314,022,000	380,936,000	376,428,000
Africa	48,626,000	42,373,000	43,600,000	43,400,000	48,000,000
Australasia	34,980,000	56,202,000	50,111,000	56,610,000	43,927,000
Total	2,948,305,000	2,765,299,000	2,609,784,000	2,897,676,000	3,124,422,000

World's visible supply of wheat the 1st of each month for ten years. [a]

Month.	1893-1894.	1894-1895.	1895-1896.	1896-1897.	1897-1898.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
July	183,700,000	172,600,000	160,300,000	137,400,000	88,700,000
August	178,200,000	174,500,000	158,000,000	124,200,000	77,500,000
September	182,900,000	189,500,000	152,200,000	126,400,000	87,000,000
October	195,700,000	205,200,000	176,500,000	151,200,000	119,100,000
November	220,600,000	220,800,000	209,800,000	190,300,000	139,300,000
December	237,500,000	218,800,000	218,700,000	202,300,000	156,000,000
January	232,000,000	227,800,000	224,700,000	184,600,000	157,000,000
February	232,900,000	223,000,000	202,800,000	173,400,000	151,700,000
March	222,400,000	212,400,000	191,900,000	155,500,000	140,500,000
April	216,500,000	198,200,000	180,600,000	139,000,000	132,000,000
May	206,900,000	186,500,000	161,100,000	121,400,000	111,200,000
June	195,700,000	171,100,000	147,500,000	106,900,000	109,800,000

Month.	1898-1899.	1899-1900.	1900-1901.	1901-1902.	1902-1903.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
July	86,700,000	140,200,000	149,800,000	136,000,000	103,671,000
August	70,100,000	134,500,000	150,100,000	132,400,000	93,944,000
September	66,500,000	142,500,000	164,600,000	141,100,000	102,364,000
October	83,000,000	162,800,000	188,200,000	159,500,000	133,376,000
November	106,800,000	191,100,000	200,800,000	169,900,000	163,491,000
December	135,800,000	203,400,000	208,200,000	202,100,000	179,483,000
January	147,100,000	202,700,000	200,500,000	201,000,000	170,640,000
February	146,400,000	190,500,000	197,900,000	202,300,000	168,170,000
March	151,100,000	181,500,000	192,700,000	191,900,000	163,658,000
April	144,900,000	184,100,000	187,800,000	72,060,000	....
May	139,500,000	175,700,000	171,800,000	68,160,000	....
June	136,900,000	157,400,000	152,500,000	69,020,000	....

[a] From Broomhall's Corn Trade News.

World's export of wheat and flour for five years, 1898-1902. [a]

[Crop years ending August 1.]

Country.	1898.	1899.	1900.	1901.	1902.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
America	231,504,000	224,784,000	186,248,000	246,168,000	261,248,000
Russia	128,480,000	68,208,000	54,984,000	75,744,000	87,448,000
Balkan Peninsula	24,904,000	27,152,000	16,384,000	40,152,000	44,152,000
Argentina and Uruguay	23,216,000	42,392,000	80,352,000	38,456,000	21,144,000
India	31,976,000	26,408,000	2,636,000	5,056,000	15,600,000
Australia and New Zealand	1,544,000	9,120,000	7,108,000	18,432,000	14,792,000
For 5 years	441,624,000	398,064,000	347,712,000	424,008,000	444,384,000

[a] From Broomhall's Corn Trade News.

Visible supply of wheat in the United States and Canada, 1st of each month for ten years.

EAST OF ROCKY MOUNTAINS. [a]

Month.	1893-1894.	1894-1895.	1895-1896.	1896-1897.	1897-1898.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
July	75,366,000	65,250,000	53,568,000	61,354,000	27,090,000
August	69,889,000	69,766,000	46,767,000	58,414,000	23,793,000
September	64,823,000	79,826,000	44,732,000	57,588,000	20,073,000
October	71,108,000	92,100,000	55,078,000	63,955,000	31,508,000
November	83,265,000	108,072,000	75,598,000	76,716,000	42,609,000
December	96,597,000	113,116,000	87,688,000	76,433,000	50,059,000
January	99,542,000	113,707,000	97,769,000	73,270,000	54,173,000
February	98,836,000	106,917,000	97,592,000	68,092,000	51,105,000
March	93,926,000	98,745,000	94,538,000	61,624,000	46,532,000
April	89,362,000	91,286,000	90,442,000	55,946,000	40,901,000
May	82,085,000	80,454,000	80,390,000	49,684,000	31,339,000
June	71,816,000	64,375,000	68,773,000	37,975,000	29,226,000

[a] The figures for stocks east of the Rocky Mountains represent 62 principal points of accumulation, including the Manitoba elevators and stocks afloat on lakes and canals, as reported by Bradstreet's.

Visible supply of wheat in the United States and Canada, etc.—Continued.

EAST OF ROCKY MOUNTAINS—Continued.

Month.	1898–1899.	1899–1900.	1900–1901.	1901–1902.	1902–1903.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
July	18,069,000	46,870,000	58,523,000	39,317,000	27,453,000
August	12,325,000	48,622,000	60,398,000	40,924,000	31,436,000
September	11,499,000	48,087,000	66,240,000	39,348,000	32,366,000
October	22,857,000	60,040,000	76,071,000	51,442,000	40,454,000
November	31,864,000	77,195,000	82,238,000	64,616,000	63,480,000
December	45,914,000	84,687,000	86,591,000	85,631,000	77,288,000
January	50,126,000	89,265,000	87,911,000	94,900,000	80,769,000
February	51,648,000	87,473,000	86,324,000	88,800,000	81,748,000
March	51,085,000	85,570,000	80,704,000	84,315,000	78,083,000
April	51,238,000	79,690,000	75,501,000	75,598,000	70,141,000
May	47,258,000	70,764,000	60,298,000	54,610,000	52,585,000
June	42,092,000	57,617,000	47,109,000	37,676,000	....

PACIFIC COAST.

Month.	1893–1894.	1894–1895.	1895–1896.	1896–1897.	1897–1898.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
July	2,842,000	8,253,000	6,549,000	1,927,000	1,112,000
August	4,487,000	8,321,000	4,762,000	1,917,000	2,247,000
September	6,114,000	8,532,000	8,799,000	3,512,000	4,651,000
October	7,162,000	9,074,000	9,760,000	5,454,000	6,251,000
November	7,760,000	13,130,000	9,651,000	6,883,000	7,391,000
December	10,629,000	14,582,000	8,276,000	6,548,000	6,944,000
January	10,721,000	13,302,000	7,116,000	4,189,000	6,661,000
February	9,859,000	13,118,000	5,859,000	3,005,000	5,318,000
March	9,622,000	11,801,000	4,296,000	1,857,000	4,424,000
April	9,005,000	10,456,000	3,822,000	1,730,000	3,466,000
May	9,378,000	10,150,000	3,182,000	1,614,000	3,051,000
June	8,704,000	8,445,000	2,556,000	1,221,000	3,236,000

Month.	1898–1899.	1899–1900.	1900–1901.	1901–1902.	1902–1903.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
July	2,935,000	3,409,000	5,903,000	3,228,000	2,676,000
August	2,608,000	4,188,000	5,770,000	3,935,000	2,345,000
September	3,005,000	6,282,000	7,483,000	4,266,000	3,024,000
October	4,671,000	8,858,000	10,208,000	6,325,000	4,787,000
November	5,621,000	11,085,000	9,983,000	7,262,000	4,719,000
December	6,296,000	10,678,000	10,057,000	7,378,000	5,361,000
January	5,923,000	10,022,000	8,686,000	7,186,000	4,992,000
February	5,039,000	8,923,000	8,717,000	6,521,000	4,373,000
March	5,104,000	7,814,000	6,972,000	5,542,000	3,435,000
April	4,321,000	7,207,000	6,325,000	5,428,000	3,810,000
May	4,455,000	7,050,000	5,071,000	3,685,000	3,683,000
June	3,635,000	6,866,000	4,672,000	3,139,000	....

Statement showing the amount of wheat in farmers' hands, visible supply of the United States and the world, and price, on March 1, 1891–1903.

Year.	Stocks in farmers' hands in United States.	Visible supply of the United States.	Visible supply of the world.	Price at Chicago.
	Bushels.	*Bushels.*	*Bushels.*	*Cts. per bu.*
1891	112,000,000	42,401,815	....	$94\frac{1}{4}$
1892	171,070,881	64,377,444	181,400,000	$87\frac{3}{8}$
1893	135,205,430	109,370,000	229,300,000	72[illegible]
1894	114,060,440	93,926,000	222,400,000	$58\frac{3}{8}$
1895	74,999,790	98,745,000	212,400,000	$52\frac{1}{4}$
1896	123,045,290	94,538,000	191,900,000	$66\frac{1}{2}$
1897	88,149,072	61,624,000	155,500,000	$74\frac{1}{2}$
1898	121,320,500	46,532,000	140,500,000	$104\frac{1}{2}$
1899	198,056,496	51,085,000	151,100,000	$72\frac{7}{8}$
1900	158,700,000	85,570,000	181,500,000	$64\frac{1}{8}$
1901	128,100,000	80,704,000	192,700,000	74
1902	173,703,000	84,315,000	191,900,000	76
1903	164,047,000	78,083,000	163,658,000	$74\frac{1}{2}$

Condition of wheat crop in the United States, monthly, 1886–1902.

Year.	Winter wheat.					Spring wheat.			
	April.	May.	June.	July.	When harvested.	June.	July.	August.	When harvested.
1886	94.1	94.9	92.7	91.2	90.8	98.5	83.3	80.1	83.5
1887	88.1	85.8	84.9	83.5	84.0	87.3	79.3	78.8	78.1
1888	82.0	73.1	73.3	75.6	77.4	92.8	95.9	87.3	77.2
1889	94.0	96.0	93.1	92.0	89.4	94.4	83.3	81.2	83.8
1890	81.0	80.0	78.1	76.2	73.5	91.3	94.4	83.2	79.8
1891	96.9	97.9	96.6	96.2	96.7	92.6	94.1	95.5	97.2
1892	81.2	84.0	88.3	89.6	87.6	92.3	90.9	87.3	81.2
1893	77.4	75.3	75.5	77.7	a74.0	86.4	74.1	67.0	....
1894	86.7	81.4	83.2	83.9	a83.7	88.0	68.4	67.1	....
1895	81.4	82.9	71.1	65.8	a75.4	97.8	102.2	95.9	....
1896	77.1	82.7	77.9	75.6	a74.6	99.9	93.3	78.9	....
1897	81.4	80.2	78.5	81.2	a85.7	89.6	91.2	86.7	....
1898	86.7	86.5	90.8	85.7	a86.7	100.9	95.0	96.5	....
1899	77.9	76.2	67.3	65.6	a70.9	91.4	91.7	83.6	....
1900	82.1	88.9	82.7	80.8	a69.6	87.3	55.2	56.4	....
1901	91.7	94.1	87.8	88.3	a82.8	92.0	95.6	80.3	....
1902	78.7	76.4	76.1	77.0	a80.0	95.4	92.4	89.7	....

a Includes both winter and spring.

Acreage, production, value, prices, and exports of wheat of the United States, 1866–1902.

Year.	Acreage.	Average yield per acre.	Production.	Average farm price per bushel, Dec. 1.	Farm value, Dec. 1.	Chicago cash price per bushel.				Domestic exports, including flour, fiscal years beginning July 1.
						December.		May of following year.		
						Low.	High.	Low.	High.	
	Acres.	*Bush.*	*Bushels.*	*Cents.*	*Dollars.*	*Cts.*	*Cts.*	*Cts.*	*Cts.*	*Bushels.*
1866	15,424,496	9.9	151,999,906	152.7	232,109,630	129	145	185	211	12,646,941
1867	18,321,561	11.6	212,441,400	145.2	308,387,146	126	140	134	161	25,284,803
1868	18,460,132	12.1	324,036,600	108.5	243,032,746	80	88	87	96	29,717,201
1869	19,181,004	13.6	260,146,900	76.5	199,024,996	63	76	79	92	53,900,780
1870	18,992,591	12.4	235,884,700	94.4	222,766,969	91	98	113	120	52,580,111
1871	19,943,893	11.6	230,722,400	114.5	264,075,851	107	111	120	143	38,995,755
1872	20,858,359	11.9	249,997,100	111.4	278,522,068	97	108	112	122	52,014,715
1873	22,171,676	12.7	281,254,700	106.9	300,669,533	96	106	105	114	91,510,398
1874	24,967,027	12.3	308,102,700	86.3	265,881,167	78	83	78	94	72,912,817
1875	26,381,512	11.1	292,136,000	89.5	261,396,926	82	91	89	100	74,750,682
1876	27,627,021	10.5	289,356,500	96,3	278,697,238	104	117	130	172	57,043,936
1877	26,277,546	13.9	364,194,146	105.7	385,089,444	103	108	98	113	92,071,726
1878	32,108,560	13.1	420,122,400	77.6	325,814,119	81	84	91	102	150,502,506
1879	32,545,950	13.8	448,756,630	110.8	497,030,142	122	133½	112½	119	180,304,180
1880	37,986,717	13.1	498,549,868	95.1	474,201,850	93½	109¾	101	112⅝	186,321,514
1881	37,709,020	10.2	383,280,090	119.2	456,880,427	124¾	129	123	140	121,892,389
1882	37,067,194	13.6	504,185,470	88.4	445,602,125	91⅛	94¾	108	113⅜	147,811,316
1883	36,455,593	11.6	421,086,160	91.1	383,649,272	94⅝	99¼	85	94¾	111,534,182
1884	39,475,885	13.0	512,765,000	64.5	330,862,260	69½	76⅜	85⅜	90¾	132,570,366
1885	34,189,246	10.4	357,112,000	77.1	275,320,390	82⅞	89	72⅛	79	94,565,793
1886	36,806,184	12.4	457,218,000	68.7	314,226,020	75⅛	79½	80¾	88¾	153,804,969
1887	37,641,783	12.1	456,329,000	68.1	310,612,960	75⅛	79¼	81¼	89⅞	119,625,344
1888	37,336,138	11.1	415,868,000	92.6	385,248,030	96⅝	105½	77¼	95½	88,600,742
1889	38,123,859	12.9	490,560,000	69,8	342,491,707	76¾	80½	89¾	100	109,430,467
1890	36,087,154	11.1	399,262,000	83.8	334,773,678	87½	92¾	98⅞	108	106,181,316
1891	39,916,897	15.3	611,780,000	83.9	513,472,711	89⅜	93¼	80	85¾	225,665,812
1892	38,554,430	13.4	515,949,000	62.4	322,111,881	69½	73	68¼	76¼	191,912,635
1893	34,629,418	11.4	396,131,725	53.8	213,171,381	59⅛	64⅛	52⅛	60½	164,283,129
1894	34,882,436	13.2	460,267,416	49.1	225,902,025	52¾	63⅝	60¾	85⅜	144,812,718
1895	34,047,332	13.7	467,102,947	50.9	237,938,998	53¾	64¾	57⅛	67⅝	126,443,968
1896	34,618,646	12.4	427,684,346	72.6	310,602,539	74⅝	93⅛	68¾	97⅞	145,124,972
1897	39,465,066	13.4	530,149,168	80.8	428,547,121	92	109	117	185	217,306,005
1898	44,055,278	15.3	675,148,705	58.2	392,770,320	62¾	70	68⅜	79½	222,618,420
1899	44,592,516	12.3	547,303,846	58.4	319,545,259	64	69½	63⅝	67½	186,096,762
1900	42,495,385	12.3	522,229,505	61.9	323,515,177	69¼	75⅝	70	75⅛	215,990,073
1901	49,895,514	15.0	748,460,218	62.4	467,350,156	73	79½	72⅜	76¼	234,772,516
1902	46,202,424	14.5	670,063,008	63.0	422,224,117	71⅞	77¾	......	......	....

Acreage, production, value, and distribution of wheat of the United States in 1902, by States.

States and Territories.	Crop of 1902.			Stock on hand Mar. 1, 1903.		Shipped out of county where grown.
	Acreage.	Production.	Value.			
	Acres.	*Bushels.*	*Dollars.*	*Bushels.*	*Per cent.*	*Bushels.*
Maine	8,383	212,090	195,123	76,352	36	....
Vermont	1,725	32,430	35,349	13,621	42	....
New York	478,196	8,033,693	6,346,617	2,169,097	27	1,606,739
New Jersey	106,004	1,696,064	1,289,009	424,016	25	373,134
Pennsylvania	1,558,745	24,628,171	17,978,565	9,358,705	38	7,388,451
Delaware	108,660	1,792,890	1,344,668	358,578	20	1,075,734
Maryland	757,090	11,129,223	8,013,041	1,891,968	17	6,788,826
Virginia	637,806	3,635,494	2,872,040	581,679	16	1,017,938
North Carolina	576,558	3,055,757	2,811,296	672,267	22	122,230
South Carolina	267,673	1,498,969	1,528,948	224,845	15	29,979
Georgia	284,531	1,707,186	1,673,042	324,365	19	34,144
Alabama	105,486	632,916	588,612	88,608	14	18,987
Mississippi	3,488	27,904	23,718	2,790	10	....
Texas	959,253	8,633,277	6,647,623	949,660	11	863,328
Arkansas	246,801	2,245,889	1,504,746	628,849	28	179,671
Tennessee	840,381	6,050,743	4,598,565	1,391,671	23	1,573,193
West Virginia	356,264	2,743,233	2,249,451	658,376	24	274,323
Kentucky	807,692	7,511,536	5,558,537	1,877,884	25	1,802,769
Ohio	2,124,759	36,333,379	25,796,699	11,263,347	31	16,713,354
Michigan	1,056,114	18,693,218	12,893,320	4,860,257	26	7,477,287
Indiana	2,217,778	35,481,448	24,129,425	8,516,268	24	20,226,135
Illinois	1,821,337	32,601,932	19,235,140	6,846,406	21	12,388,734
Wisconsin	532,104	9,655,094	6,179,260	3,572,385	37	1,641,366
Minnesota	5,737,583	79,752,404	48,648,966	23,128,197	29	59,016,779
Iowa	1,174,891	14,869,245	8,178,085	4,163,389	28	3,419,926
Missouri	2,827,462	56,266,491	32,634,567	14,629,288	26	33,197,231
Kansas	4,395,319	45,827,495	25,205,122	10,540,324	23	29,329,597
Nebraska	2,525,150	52,726,451	25,835,961	17,926,993	34	37,435,780
South Dakota	3,604,347	43,973,033	25,064,629	11,872,719	27	33,859,235
North Dakota	3,954,229	62,872,241	36,465,900	11,317,003	18	53,441,405
Montana	90,583	2,355,158	1,460,198	612,341	26	612,341
Wyoming	23,130	543,555	440,280	130,453	24	48,920
Colorado	293,770	5,287,860	3,965,895	1,004,693	19	2,115,144
New Mexico	45,624	780,170	670,946	85,819	11	15,603
Arizona	18,754	350,700	368,235	35,070	10	73,647
Utah	176,824	3,748,669	2,848,988	1,312,034	35	1,162,087
Nevada	19,839	537,637	526,884	96,775	18	16,129
Idaho	273,080	6,021,946	4,215,362	1,445,267	24	3,733,607
Washington	1,065,451	23,672,187	15,386,921	3,077,384	13	16,097,087
Oregon	777,377	15,512,460	10,393,348	1,706,371	11	9,152,351
California	2,052,679	22,374,201	17,899,361	1,566,194	7	15,214,457
Oklahoma	1,087,747	12,073,992	7,002,915	2,173,319	18	8,693,274
Indian Territory	201,754	2,481,574	1,513,760	471,499	19	322,605
United States	46,202,424	670,063,008	422,224,117	164,047,106	24.5	388,553,527

THE CENTER OF GRAIN PRODUCTION.

The figures of the last census, when compared with those of the previous census reports back to 1850, indicate that the movement of the production of grain under natural conditions has about reached its western limit. Since 1850 the "median point" (center) of production of the six great crops—corn, wheat, oats, barley, rye, and buckwheat—was about 20 miles east of Cincinnati, Ohio, and in 1900 it had moved to a point 31 miles west-southwest of Burlington, Iowa; but its western movement in the last ten years was comparatively very small. It remains to be seen what effect the great irrigation work now planned by the Government will have upon the location of the great grain fields of the country.

Acreage, production, and value of winter and spring wheat in the United States in 1902.

States and Territories.	Winter wheat.					Spring wheat.				
	Acreage.	Yield per acre.	Production.	Price per bushel.	Total value.	Acreage.	Yield per acre.	Production.	Price per bushel.	Total value.
	Acres.	*Bu.*	*Bushels.*	*Cts.*	*Dollars.*	*Acres.*	*Bu.*	*Bushels.*	*Cts.*	*Dollars.*
Maine						8,383	25.3	212,090	92	195,123
Vermont						1,725	18.8	32,430	109	35,349
New York	478,196	16.8	8,033,693	79	6,346,617					
New Jersey	106,004	16.0	1,696,064	76	1,289,009					
Pennsylvania	1,558,745	15.8	24,628,171	73	17,978,565					
Delaware	108,660	16.5	1,792,890	75	1,344,668					
Maryland	757,090	14.7	11,129,223	72	8,013,041					
Virginia	637,806	5.7	3,635,494	79	2,872,040					
North Carolina	576,558	5.3	3,055,757	92	2,811,296					
South Carolina	267,673	5.6	1,498,969	102	1,528,948					
Georgia	284,531	6.0	1,707,186	98	1,673,042					
Alabama	105,486	6.0	632,916	93	588,612					
Mississippi	3,488	8.0	27,904	85	23,718					
Texas	959,253	9.0	8,633,277	77	6,647,623					
Arkansas	246,801	9.1	2,245,889	67	1,504,746					
Tennessee	840,381	7.2	6,050,743	76	4,598,565					
West Virginia	356,264	7.7	2,743,233	82	2,249,451					
Kentucky	807,692	9.3	7,511,536	74	5,558,537					
Ohio	2,124,759	17.1	36,333,379	71	25,796,699					
Michigan	1,056,114	17.7	18,693,218	69	12,898,320					
Indiana	2,217,778	16.0	35,484,448	68	24,129,425					
Illinois	1,821,337	17.9	32,601,932	59	19,235,140					
Wisconsin	120,058	18.3	2,197,061	64	1,406,119	412,046	18.1	7,458,033	64	4,773,141
Minnesota						5,737,583	13.9	79,752,404	61	48,648,966
Iowa	80,401	17.5	1,407,018	55	773,860	1,094,490	12.3	13,462,227	55	7,404,225
Missouri	2,827,462	19.9	56,266,494	58	32,634,567					
Kansas	4,162,965	10.4	43,294,836	55	23,812,160	232,354	10.9	2,532,659	55	1,392,962
Nebraska	1,895,362	23.2	43,972,398	49	21,546,475	629,788	13.9	8,754,053	49	4,289,486
South Dakota						3,604,347	12.2	43,973,033	57	25,064,629
North Dakota						3,954,229	15.9	62,872,241	58	36,465,900
Montana						90,583	26.0	2,355,158	62	1,460,198
Wyoming						23,130	23.5	543,555	81	440,280
Colorado						293,770	18.0	5,287,860	75	3,965,895
New Mexico						45,621	17.1	780,170	86	670,946
Arizona						18,754	18.7	350,700	105	368,235
Utah						176,824	21.2	3,748,669	76	2,848,988
Nevada						19,839	27.1	537,637	98	526,884
Idaho	131,222	22.0	2,886,884	70	2,020,819	141,858	22.1	3,135,062	70	2,194,543
Washington	308,315	25.7	7,923,696	65	5,150,402	757,139	20.8	15,748,491	65	10,236,519
Oregon	398,845	22.0	8,774,590	67	5,878,975	378,532	17.8	6,737,870	67	4,514,373
California	2,052,679	10.9	22,374,201	80	17,899,361					
Oklahoma	1,087,747	11.1	12,073,992	58	7,002,915					
Indian Ter	201,754	12.3	2,481,574	61	1,513,769					
United States	28,581,426	14.4	411,788,666	64.8	266,727,475	17,620,998	14.7	258,274,342	60.2	155,496,642

WINTER WHEAT AND SPRING WHEAT.

The separate statement on this page of the figures for winter wheat and for spring wheat will afford a new line for observation of the development of wheat growing in the United States. It will be noticed that the production of spring wheat, while it constitutes nearly one-half of the total, is rather closely confined to the States whose climates will hardly allow fall seeding with a safe prospect of a crop. On the Pacific coast a considerable share of the crops of Washington and Oregon are spring wheat, but this wheat probably comes from the colder sections in the eastern parts of those States.

Average yield per acre of wheat in the United States, 1893–1902, by States.

States and Territories.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.
	Bush.	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*
Maine	16.0	21.1	19.2	22.9	16.5	19.5	22.5	19.5	24.9	25.6
New Hampshire	15.0	20.0	19.3	21.0	16.0	19.0	17.2	16.3	......	......
Vermont	16.8	22.7	29.0	24.5	17.0	22.5	22.9	23.5	18.7	18.5
Connecticut	18.3	......	......	......	20.9	20.0	18.3	20.8	......	......
New York	14.5	14.8	18.1	16.0	21.4	21.2	18.5	17.7	16.1	16.8
New Jersey	14.5	15.3	12.4	15.3	18.5	17.4	14.5	19.1	19.8	16.9
Pennsylvania	14.0	15.6	16.6	14.0	19.7	17.5	13.6	13.5	17.1	15.8
Delaware	14.7	13.0	11.6	18.0	21.5	13.3	12.8	20.3	18.5	16.5
Maryland	13.5	15.3	17.0	17.0	19.2	15.3	14.1	19.5	17.2	14.7
Virginia	11.2	9.5	9.3	9.3	12.0	14.1	8.4	11.9	10.9	5.7
North Carolina	8.2	5.0	6.9	7.3	8.0	9.2	6.7	9.6	8.7	5.3
South Carolina	6.3	5.6	6.4	6.8	8.7	10.6	6.5	9.0	8.8	5.6
Georgia	7.2	6.9	6.2	8.0	9.4	10.0	6.8	9.1	8.2	6.9
Alabama	8.2	8.3	7.5	8.0	10.0	12.0	7.6	9.5	8.7	6.0
Mississippi	7.5	9.8	8.0	8.5	10.0	13.9	7.7	9.6	8.8	8.0
Texas	10.5	15.1	5.7	11.7	15.8	14.8	11.1	18.4	8.9	9.0
Arkansas	8.0	8.8	9.4	8.0	10.5	11.0	8.6	10.1	8.8	9.1
Tennessee	9.2	8.1	8.8	8.5	11.2	13.2	8.7	9.9	10.8	7.2
West Virginia	11.5	12.1	10.6	10.3	13.4	13.8	9.3	9.8	10.9	7.7
Kentucky	11.3	12.5	10.9	8.7	13.6	15.4	9.1	13.0	12.1	9.3
Ohio	14.5	19.0	13.3	9.0	16.9	16.9	14.2	6.0	15.3	17.1
Michigan	13.2	15.8	13.2	12.8	15.6	20.8	8.4	7.6	11.1	17.7
Indiana	14.1	18.4	9.2	9.0	13.0	15.6	9.8	5.3	15.8	16.0
Illinois	11.5	18.2	11.0	14.7	7.9	11.0	10.0	13.0	17.6	17.9
Wisconsin	13.3	16.5	15.5	13.3	12.5	18.0	15.5	15.5	16.1	13.1
Minnesota	9.6	13.5	23.0	14.2	13.0	15.8	13.4	10.5	12.9	13.9
Iowa	11.5	14.8	19.5	16.0	13.0	16.7	13.0	15.6	16.2	12.7
Missouri	9.5	15.3	12.0	11.7	9.0	9.8	9.9	12.5	16.9	19.9
Kansas	8.4	10.4	7.7	10.6	15.5	14.2	9.8	17.7	18.5	10.4
Nebraska	8.7	7.0	12.0	14.0	14.5	16.4	10.3	12.0	17.1	20.9
South Dakota	8.5	6.6	12.0	11.2	8.0	12.4	10.7	6.9	12.9	12.2
North Dakota	9.6	11.8	21.0	11.8	10.3	14.4	12.8	4.9	13.1	15.9
Montana	21.5	24.8	23.9	26.5	32.5	29.5	25.7	26.6	25.5	26.0
Wyoming	18.7	19.6	26.0	24.5	25.0	23.7	18.8	17.6	24.5	23.5
Colorado	13.2	17.9	23.5	17.5	24.0	26.3	23.7	22.6	24.1	18.0
New Mexico	16.8	18.0	20.4	21.0	24.0	23.8	13.8	21.0	21.5	17.1
Arizona	17.5	17.0	20.5	23.0	18.0	31.7	15.3	14.6	21.8	18.7
Utah	13.8	22.0	22.4	26.5	21.0	28.0	20.7	20.9	20.5	21.2
Nevada	14.7	20.0	21.7	30.0	24.3	29.0	18.0	24.5	25.1	27.1
Idaho	19.3	20.6	17.8	24.5	22.0	31.0	24.2	20.8	21.2	22.1
Washington	20.3	16.6	15.5	18.0	23.5	24.2	22.7	23.5	20.1	22.2
Oregon	17.5	17.7	20.0	17.0	17.0	20.5	19.2	13.8	21.1	20.0
California	13.3	11.3	13.0	14.6	10.0	9.1	14.1	10.3	13.0	10.9
Oklahoma	......	11.3	11.4	13.0	19.0	14.9	13.3	19.0	16.4	11.1
Indian Territory	......	......	......	......	......	......	......	......	12.2	12.3
General average	11.4	13.2	13.7	12.4	13.4	15.3	12.3	12.3	15.0	14.5

Average yield of wheat in certain countries, in bushels per acre, 1894–1900.

Year.	United States.	Russia.	Germany.	Austria.	Hungary.	France.	United Kingdom.
	(a)	(b)	(b)	(b)	(b)	(a)	(a)
1894	13.2	10.8	25.1	17.4	18.2	20.1	31.7
1895	13.7	9.8	24.4	15.3	20.7	19.7	27.2
1896	12.4	9.0	26.4	15.9	19.4	20.0	34.7
1897	13.4	7.3	25.3	13.2	11.7	15.1	30.0
1898	15.3	9.8	27.2	18.0	17.1	21.1	35.8
1899	12.3	9.1	28.4	18.9	17.8	21.2	33.8
1900	12.3	8.1	27.9	15.5	16.9	19.2	29.5
1901	14.5	7.9	23.5	16.7	15.1	18.5	31.9
Average	13.4	9.0	26.0	16.4	17.1	19.4	31.8

a Winchester bushels. *b* Bushels of 60 pounds.

Average value per acre of wheat in the United States, based upon farm value December 1, 1893–1902, by States.

States and Territories.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.
Maine	$16.32	$16.67	$15.74	$18.48	$17.49	$17.36	$20.47	$17.55	$23.18	$23.28
New Hampshire	12.75	16.00	14.67	21.00	17.60	17.48	16.34	15.00	......	......
Vermont	14.28	15.21	20.01	22.79	17.68	20.25	18.70	18.33	17.58	20.49
Connecticut	......	......	......	......	20.00	17.60	17.39	17.05	......	......
New York	11.02	9.18	12.31	14.08	19.26	15.26	14.80	13.63	10.74	13.27
New Jersey	10.15	9.33	8.80	13.62	17.20	12.70	10.88	14.13	12.10	12.16
Pennsylvania	9.10	8.40	10.79	11.62	17.93	11.90	8.98	9.72	12.31	11.53
Delaware	8.82	7.15	7.42	15.66	20.21	9.18	8.70	14.21	13.13	12.38
Maryland	10.26	8.26	10.88	14.96	17.86	10.71	9.59	13.84	12.21	10.58
Virginia	7.06	5.32	6.05	7.44	11.04	9.31	5.80	8.57	7.96	4.50
North Carolina	5.90	3.25	4.97	6.06	7.52	7.18	5.49	7.87	7.13	4.88
South Carolina	6.17	4.87	5.63	6.05	10.27	9.96	6.44	9.09	8.62	5.71
Georgia	6.48	5.24	5.08	7.12	9.68	9.80	6.66	8.64	7.71	5.88
Alabama	7.22	6.47	6.00	6.80	10.10	10.80	6.76	8.45	7.66	5.58
Mississippi	6.55	7.35	4.88	6.97	9.90	11.54	6.01	8.06	7.57	6.80
Texas	6.09	8.15	3.76	8.78	14.06	10.06	7.55	11.78	6.94	6.93
Arkansas	5.20	4.84	5.55	5.68	8.82	6.38	5.50	6.57	6.86	6.10
Tennessee	5.24	4.13	5.46	6.29	10.64	8.84	6.79	7.82	7.99	5.47
West Virginia	8.28	7.26	7.31	8.03	11.93	9.80	6.60	7.55	8.39	6.31
Kentucky	6.44	6.25	6.65	6.61	12.10	9.55	6.01	8.97	8.71	6.88
Ohio	8.27	9.31	7.98	7.02	14.87	11.15	9.09	4.26	10.86	12.14
Michigan	7.52	8.22	7.92	10.75	13.57	13.31	5.46	5.24	7.88	12.21
Indiana	7.47	8.46	5.24	7.20	11.57	9.83	6.27	3.71	11.06	10.88
Illinois	5.87	8.19	5.83	10.88	7.03	6.60	6.30	8.32	12.14	10.56
Wisconsin	7.18	8.42	7.91	9.31	10.50	10.62	9.46	9.92	10.48	11.61
Minnesota	4.90	6.62	10.12	9.66	10.01	8.53	7.37	6.62	7.74	8.48
Iowa	5.64	7.40	8.97	9.92	9.75	8.68	7.15	9.20	9.75	6.96
Missouri	4.56	6.58	6.12	8.19	7.65	5.78	6.14	7.88	10.97	11.54
Kansas	3.53	4.58	3.47	6.68	11.47	7.10	5.10	9.73	10.92	5.73
Nebraska	3.48	3.43	4.80	8.12	10.00	7.71	5.05	6.36	9.23	10.23
South Dakota	3.74	3.04	4.56	6.94	5.52	6.20	5.35	4.00	6.84	6.95
North Dakota	4.13	5.07	7.98	7.55	7.62	7.34	6.53	2.84	7.07	9.22
Montana	12.90	13.39	17.45	17.49	22.10	17.11	15.68	16.23	17.76	16.12
Wyoming	12.15	12.35	16.64	15.19	17.50	16.35	12.60	13.38	16.91	19.04
Colorado	6.86	11.64	13.16	10.67	16.80	14.73	13.51	13.33	16.15	13.50
New Mexico	12.60	15.84	14.89	13.86	18.00	14.76	8.42	14.28	15.48	14.71
Arizona	11.38	17.00	13.33	18.40	13.32	29.16	9.79	11.53	18.53	19.64
Utah	8.28	11.66	9.86	18.02	14.28	15.12	10.97	11.49	14.35	16.11
Nevada	10.73	15.00	10.63	20.70	21.87	27.55	13.68	17.15	22.09	25.56
Idaho	11.58	9.48	8.37	15.93	15.40	15.81	12.10	9.57	12.93	15.44
Washington	9.74	6.47	6.35	13.32	15.98	13.07	11.58	11.99	13.67	14.44
Oregon	9.63	7.61	9.40	12.24	12.24	12.71	10.18	7.59	11.37	13.37
California	7.05	6.44	7.80	12.12	8.30	6.55	8.74	5.97	7.80	8.72
Oklahoma	......	5.76	5.47	8.84	14.44	7.75	7.05	10.07	10.33	6.44
Indian Territory	......	......	......	......	......	......	......	......	8.42	7.50
General average	6.16	6.48	6.99	8.97	10.86	8.92	7.17	7.61	9.37	9.14

Macaroni Wheat.

The introduction into the semiarid regions of the West of several new varieties of wheat suitable for making macaroni has been very successful. It is estimated that about 2,000,000 bushels were raised last year and that the quantity will be increased this year. Care is being taken in grading and handling it and mills have prepared to grind it, so that no difficulty will be experienced in supplying the macaroni factories of the country a considerable share of the semolina (flour) they need. There is a prospect that in a few years there will no longer be any necessity for the manufacturers to import any part of their supply, and it may happen that the United States will become an exporter of macaroni wheat on a large scale.

Average farm price of wheat per bushel in the United States December 1, 1893–1902, by States.

States and Territories.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.
Maine	$1.02	$0.79	$0.82	$0.84	$1.06	$0.89	$0.91	$0.90	$0.97	$0.92
New Hampshire	.85	.80	.76	1.00	1.10	.92	.95	.92	......	......
Vermont	.85	.67	.69	.93	1.04	.90	.85	.78	.94	1.09
Connecticut	......	......	.68	......	1.00	.88	.95	.82	......	......
New York	.76	.62	.68	.88	.90	.72	.80	.77	.82	.79
New Jersey	.70	.61	.71	.89	.93	.73	.75	.74	.72	.76
Pennsylvania	.65	.56	.65	.83	.91	.68	.66	.72	.72	.73
Delaware	.60	.55	.64	.87	.94	.69	.68	.70	.71	.75
Maryland	.76	.54	.64	.88	.93	.70	.68	.71	.71	.72
Virginia	.63	.56	.65	.80	.92	.66	.69	.72	.73	.79
North Carolina	.72	.65	.72	.83	.94	.78	.82	.82	.82	.92
South Carolina	.98	.87	.88	.89	1.18	.94	.99	1.01	.98	1.02
Georgia	.90	.76	.82	.89	1.03	.98	.98	.95	.94	.98
Alabama	.88	.78	.80	.85	1.01	.90	.89	.89	.88	.93
Mississippi	.85	.75	.61	.82	.99	.83	.78	.84	.86	.85
Texas	.58	.54	.66	.75	.89	.68	.68	.64	.78	.77
Arkansas	.65	.55	.59	.71	.84	.58	.64	.65	.78	.67
Tennessee	.57	.51	.62	.74	.95	.67	.78	.79	.74	.76
West Virginia	.72	.60	.69	.78	.89	.71	.71	.77	.77	.82
Kentucky	.57	.50	.61	.76	.89	.62	.66	.69	.72	.74
Ohio	.57	.49	.60	.78	.88	.66	.64	.71	.71	.71
Michigan	.57	.52	.60	.84	.87	.64	.65	.69	.71	.69
Indiana	.53	.46	.57	.80	.89	.63	.64	.70	.70	.68
Illinois	.51	.45	.53	.74	.89	.60	.63	.64	.69	.59
Wisconsin	.54	.51	.51	.70	.84	.59	.61	.64	.65	.64
Minnesota	.51	.49	.44	.68	.77	.54	.55	.63	.60	.61
Iowa	.49	.50	.46	.62	.75	.52	.55	.59	.60	.55
Missouri	.48	.43	.51	.70	.85	.59	.62	.63	.69	.58
Kansas	.42	.44	.45	.63	.74	.50	.52	.55	.59	.55
Nebraska	.40	.49	.40	.58	.69	.47	.49	.53	.54	.49
South Dakota	.44	.46	.38	.62	.69	.50	.50	.58	.53	.51
North Dakota	.43	.43	.38	.64	.74	.51	.51	.58	.54	.58
Montana	.60	.54	.73	.66	.68	.58	.61	.61	.67	.62
Wyoming	.65	.63	.64	.62	.70	.69	.67	.76	.69	.81
Colorado	.52	.65	.56	.61	.70	.56	.57	.59	.67	.75
New Mexico	.75	.88	.73	.66	.75	.62	.61	.68	.72	.86
Arizona	.65	1.00	.65	.80	.74	.92	.64	.79	.85	1.05
Utah	.60	.53	.44	.68	.68	.54	.53	.55	.70	.76
Nevada	.73	.75	.49	.69	.90	.95	.76	.70	.88	.98
Idaho	.60	.46	.47	.65	.70	.51	.50	.46	.61	.70
Washington	.48	.39	.41	.74	.68	.54	.51	.51	.47	.65
Oregon	.55	.43	.47	.72	.72	.62	.53	.55	.54	.67
California	.53	.57	.60	.83	.83	.72	.62	.58	.60	.80
Oklahoma	......	.51	.48	.68	.76	.52	.53	.53	.63	.58
Indian Territory	......	......	......	......	......	......	......	......	.69	.61
General average	.538	.491	.509	.726	.808	.582	.584	.619	.624	.630

Transportation rates, average for wheat, in cents, St. Louis to New Orleans by river.

Year.	Bulk, per bushel.	Sacks, per 100 lbs.	Year.	Bulk, per bushel.	Sacks, per 100 lbs.	Year.	Bulk, per bushel.	Sacks, per 100 lbs.	Year.	Bulk, per bushel.	Sacks, per 100 lbs.
1877	8.11	20.04	1884	6.63	14.00	1891	6.88	16.28	1897	4.98	15.00
1878	7.19	17.36	1885	6.40	15.00	1892	6.50	16.87	1898	4.50	10.00
1879	7.75	18.00	1886	6.50	16.00	1893	6.55	17.54	1899	4.50	10.00
1880	8.25	19.00	1887	6.00	18.25	1894	5.89	17.14	1900	4.25	10.00
1881	6.00	20.00	1888	6.50	15.00	1895	5.95	12.50	1901	4.25	10.00
1882	6.42	20.00	1889	5.95	17.93	1896	5.00	14.55	1902	4.20	10.00
1883	5.50	17.75	1890	6.58	15.66						

Wheat on the Pacific Coast.

There has been no very large increase in the total wheat crop of the Pacific Coast States in the past ten years, though the crop in 1901 reached nearly 100,000,000 bushels; but the excellent quality of the wheat produced there, and the high price it commands in the world's markets, give reasonable assurance of the continued expansion of this branch of farming. The settling up of new areas and the development of irrigation will have a tendency to make the increase of production shown by the next census not less than that shown in 1900.

Wholesale prices of wheat per bushel in leading cities of the United States, 1897–1902.

Date.	New York.		Baltimore.		Chicago.		Detroit.		St. Louis.		Minneapolis.		San Francisco.	
	No. 2, red winter.		Southern, No. 2, red.				No. 2, red.		No. 2, red winter.		No. 2, northern.		No. 1, California (per cwt.).	
	Low.	High.	Low.	High.	Low.	High.	Low.	High.	Low.	High.	Low.	High.	Low.	High.
1897.														
January	$0.91¾	$1.01⅞	$0.87	$0.97	$0.71¼	$0.91	$0.85	$0.94¾	$0.80	$0.92½	$0.71⅝	$0.79⅜	$1.50	$1.56¼
February	.88¼	.96¾	.87	.92	.71⅞	.87⅞	.85	.89	.80⅞	.89⅛	.71⅛	.73⅝	1.32½	1.40
March	.81⅝	.89⅛	.83	.92	.69⅜	.90¼	.85	.91½	.90⅞	.95½	.69⅝	.74½	1.28¾	1.36¼
April	....	....	.73	.85	.61⅛	.97	.83½	.93¾	.90	1.03	.65¼	.77⅝	1.21¼	1.30
May	....	....	.80	.90	.68¾	.97⅞	.79½	.92½	.82½	.97	.69¼	.75	1.30	1.32½
June	....	....	.55	.81	.66⅞	.83¼	.76	.83	.74	.84½	.68½	.71⅞	1.22½	1.23¾
July	....	....	.50	.85	.68¼	.79¾	.74½	.79¼	.65½	.79	.69¾	.79¼	1.21¼	1.40
August	.86⅜	1.11¼	.80	1.07½	.75¼	1.07	.77½	1.01	.79	1.03	.79¾	1.07½	1.46¼	1.55
September	.94⅛	1.07½	.89	1.04¼	.85½	1.01¼	.91½	1.00	.93¼	1.01	.85	.96¼	1.47½	1.56¼
October	.91⅜	1.05	.88	1.01	.87⅞	.99¼	.91	.97½	.93½	1.01	.85	.92½	1.45	1.47½
November	.97¼	1.03½	.90	1.01	.91	1.00½	.91	.97	.94¾	.99¾	.87¼	.92½	1.40	1.48¾
December	.97	1.03¼	.91	1.00	.92	1.09	.89¼	.94½	.95½	1.02	.86⅝	.93	1.40	1.42½
1898.														
January	.99¾	1.10½	.90	1.01½	.89⅛	1.10	.90	.97¾	.92½	1.00½	.87½	.96	1.37½	1.41¼
February	1.02¼	1.10¼	.93	1.04	.95	1.08	.93½	.99¼	.91¾	1.01	.92¾	1.00	1.41¼	1.42½
March	.99⅞	1.08⅞	.94	1.03	1.00	1.06¾	.94¼	.98½	.96	1.00	.94½	.99½	1.40	1.46¼
April	1.01	1.28	.95	1.15	1.01	1.23½	.94½	1.12½	.97	1.10	.95¼	1.16¾	1.48¾	1.80
May	1.16½	1.93½	1.10	1.46½	1.17	1.85	1.10	1.60	1.00	1.27	1.14½	1.55	1.60	1.77½
June	.82	1.21	.60	1.16½	.75	1.20	.82	1.12	.69	1.00½	.80	1.30	1.60	1.77½
July	.74½	.94	.62	.87	.65¾	.88	.66½	.90	.64½	.79	.80	.87½	1.22½	1.25
August	.73⅛	.81¾	.60	.81	.65½	.75	.67	.74	.64	.73	.70	.87	1.08¾	1.20
September	.68¾	.79⅞	.60	.73¼	.62¾	.68	.67	.70	.65	.70	.55	.63	1.10	1.18¾
October	.72	.80¼	.63	.77½	.62	.70¼	.65½	.74	.65¾	.72¾	.56	.67	1.15	1.22½
November	.74¾	.78¾	.65	.74	.64½	.69½	.69	.71¾	.67½	.71⅞	.60	.63	1.15	1.21¼
December	.73⅞	.81¼	.62	.77	.62¾	.70	.66¾	.72¼	.68½	.73	.60	.67	1.13¾	1.15
1899.														
January	.79¼	.87⅜	.76	.81½	.66½	.76	.70½	.76½	.71	.79½	.65½	.72¼	1.12½	1.18¾
February	.81	.87⅜	.74½	.78	.69¾	.74½	.72¼	.71½	.72½	.76	.67⅜	.69¼	1.10	1.13¾
March	.78⅝	.87½	.72	.78	.66	.74½	.69	.75	.69	.76	.64	.70¼	1.06¼	1.15
April	.79⅜	.85¼	.75½	.79½	.70	.76½	.71½	.76¾	.73⅝	.80	.68	.72	1.05	1.10
May	.80⅛	.87½	.73¼	.79½	.68⅜	.79½	.73¼	.80	.73¼	.81⅝	.67¼	.73	1.06¼	1.12½
June	.80	.85⅞	.75	.79	.71¼	.79¼	.75¼	.80¼	.73¾	.78½	.70½	.73⅞	1.10	1.12½
July	.75¼	.81¾	.71	.75¾	.68⅝	.75⅜	.71¼	.78	.69⅝	.75	.65⅞	.71¾	1.05	1.10
August	.71⅝	.78¼	.71	.73¼	.69	.74½	.70	.74	.68⅛	.73¼	.66	.70¼	1.03¾	1.07½
September	.73¼	.77⅜	.70½	.74½	.69⅜	.75⅛	.70½	.73½	.68	.72	.64⅞	.67⅞	1.02½	1.07½
October	.75	.78¾	.71	.75½	.68⅜	.74¾	.70½	.73⅜	.69½	.73	.61¾	.69½	1.07½	1.12½
November	.72¼	.75⅜	.68½	.72	.65	.71½	.67½	.70¾	.68½	.70½	.61¾	.61	.97½	1.07½
December	.72⅛	.76	.70	.72	.64	.69½	.68	.72	.69½	.72	.60	.61	.96¼	.98¾

											No. 1, northern.			
1900.														
January	.72⅞	.78⅜	.70	.73	.61½	.67⅛	.66¾	.72	.66¼	.72	.62	.66¼	.95	.98¾
February	.74¾	.79⅞	.73	.76	.63⅞	.67½	.70¾	.73¼	.69	.71¾	.63	.65⅞	.96¼	1.00
March	.74½	.81⅜	.71½	.75½	.64	.67	.70¼	.72½	.69	.72¼	.63¼	.66	.95	.96¼
April	.78	.81¼	.71½	.76	.64¾	.67¾	.71	.72¾	.70	.72¾	.64½	.66⅛	.95	.96¼
May	.78	.82¾	.72	.73½	.63⅝	.67½	.71¾	.74	.70¼	.71¼	.64½	.66½	.90	.95
June	.80	.96⅞	.72	.90	.65⅜	.87½	.73¼	.91½	.68¾	.86½	.64⅞	.88⅞	.91¼	1.07½
July	.81	.90¼	.73	.81½	.74	.81½	.77½	.84½	.71⅞	.80⅛	.71¾	.82¼	1.05	1.07½
August	.78¼	.83⅜	.71	.76	.71¾	.76¼	.74	.78¾	.68¾	.73	.72¼	.76	1.02½	1.05
September	.79¼	.85	.71¾	.77	.72½	.79⅜	.75¼	.80¾	.71	.77½	.73½	.81¼	1.03¾	1.05
October	.76⅞	.82⅞	.71¼	.77	.71⅜	.77⅜	.75	.79½	.69	.75½	.73⅞	.80¼	.95	1.01¼
November	.77½	.81¼	.71¾	.73¾	.69⅝	.74¼	.74¼	.77½	.69½	.72¾	.72¾	.76⅝	.97¼	1.00
December	.77⅜	.83⅛	.71½	.75½	.69¼	.74⅛	.74½	.81	.69¼	.71¼	.71⅞	.75¼	.96¼	.97½
1901														
January	.79½	.83½	.73¾	.78	.71⅜	.76⅜	.78	.82½	.72	.77	.73	.77¼	.97½	1.01¼
February	.79¾	.81¼	.76	.78¾	.72⅛	.74¾	.78⅛	.80¼	.73½	.75¾	.73	.74¼	.95	.98¼
March	.80⅛	.82¼	.77¾	.81	.73¼	.76¼	.78½	.80	.74	.75¾	.73	.74¼	.95	1.02¼
April	.78⅛	.84¾	.76½	.81½	.69½	.74⅞	.74	.78	.71	.76¼	.70¼	.74¼	1.00	1.05
May	.81¾	.84⅞	.78¾	.80½	.70	.75⅛	.74½	.77¼	.73½	.76	.70¾	.74¼	.97½	1.01¼
June	.75½	.85¼	.72	.79½	.65½	.77¼	.67¾	.77¼	.63¼	.75½	.62¾	.74¼	.96¼	1.00
July	.72¾	.79¾	.69¼	.75½	.63⅛	.71¾	.66½	.74	.61¼	.70¾	.60½	.69¾	.95	1.00
August	.76	.80½	.72	.78	.66⅝	.77	.68¼	.76½	.66¼	.73¾	.66	.71¼	.97¼	.98¼
September	.75⅜	.77⅜	.78½	.75½	.68⅛	.71	.70½	.73½	.70¼	.72¼	.64¼	.69¼	.96¼	.97¼
October	.74⅝	.80⅝	.70½	.75	.66¾	.71½	.70	.74	.70½	.73¼	.66	.68¼	.95	.98¾
November	.80⅛	.83½	.74¼	.78	.70	.73¾	.73	.79½	.72¼	.80	.68¼	.71¼	.98¼	1.01¼
December	.84¾	.89⅞	.78½	.85¾	.73	.79½	.79	.90½	.81	.88¼	.71¾	.77	1.01¼	1.0[illegible]
1902														
January	.85¾	.94¼	.81⅜	.87½	.71	.80½	.86	.93½	.86½	.92½	.73⅝	.79¼	1.05	1.08¾
February	.85⅞	.93¼	.80	.85⅝	.72⅞	.76½	.84¼	.87½	.83¼	.89	.72¼	.75⅛	1.07¼	1.12¼
March	.82	.90⅜	.76	.85	.69¾	.76	.77½	.85¾	.76⅜	.86¾	.70⅜	.75¼	1.10	1.12¼
April	.82	.92½	.75	.85½	.70	.76¾	.77½	.87¾	.77¼	.83½	.70⅜	.77¼	1.10	1.13¾
May	.88¼	.93¾	.81	.87½	.72⅜	.76¼	.80	.88	.76¼	.84¼	.74	.78	1.11¼	1.16¼
June	.87¾	.93⅜	.76	.83	.71¼	.75¾	.79	.81¼	.76	.80	.73⅛	.77¼	1.11¾	1.13¾
July	.76⅞	.92¼	.70¾	.81¾	.71½	.79	.72	.82	.65¼	.78	.76⅜	.80¼	1.13¾	1.16¼
August	.74⅞	.78⅜	.66¼	.74¼	.68¼	.76	.68½	.73	.63	.68¼	.74¼	.79¼	1.12¼	1.15
September	.73½	.77	.68	.72¾	.70	.95	.70⅞	.74	.66	.68¼	.66¼	.71¼	1.12½	1.20
October	.73⅞	.79	.69	.75½	.67½	.75½	.72	.76¼	.67¼	.72	.68	.73¼	1.18¾	1.35
November	.76	.79⅞	.71¼	.77½	.69	.77⅜	.75¼	.80¾	.69	.71	.71¾	.74¼	1.32½	1.45
December	.76½	.89¼	.71¼	.77	.71⅜	.77¼	.77¼	.83	.69	.71¼	.72¼	.74¼	1.37½	1.43¾

Monthly average prices of wheat in Chicago.[a]

[Cents per bushel.]

Month.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.
January	91 3/8	87 1/4	75 1/16	61 7/16	55 1/8	62 5/16	82 5/8	99 9/16	71 1/4	64 5/16	73 7/8	77 1/4
February	95 1/8	87 15/16	73 15/16	57 1/2	53 7/8	66 5/8	79 5/8	101 1/2	72 1/8	65 11/16	73 7/16	74 11/16
March	101 5/16	84 1/8	76	57 13/16	57 1/16	65 7/16	79 13/16	103 3/8	70 1/4	65 1/2	74 3/4	72 7/8
April	109 1/16	81 5/16	79	61 1/8	61 1/2	66 1/8	80 9/16	112 1/4	73 1/4	66 1/4	72 3/16	73 3/8
May	103 7/16	82 7/8	72 1/4	56 9/16	73 1/16	62 3/8	83 5/16	151	73 15/16	65 9/16	72 9/16	74 5/16
June	96 1/4	82 7/8	65 1/16	58 9/16	76 9/16	60 5/16	75 3/16	97 1/2	75 1/4	76 11/16	71 3/8	73 1/2
July	91 1/2	78 1/4	60 1/8	55 7/16	68	58 1/4	74	76 7/8	72	77 3/4	67 7/16	75 1/4
August	99 15/16	77 1/16	59 5/8	55	65 3/8	58 1/16	91 1/8	70 1/4	71 3/4	74	71 13/16	72 1/8
September	95 1/4	73 1/8	66 3/16	53	60 1/16	62 1/2	93 3/8	65 3/8	72 1/4	75 15/16	69 9/16	82 1/2
October	95 3/4	71 15/16	63 3/8	53 13/16	60 7/8	73 3/8	93 9/16	66 1/8	71 9/16	74 3/8	69 1/8	71 1/2
November	94 1/8	71 9/16	60 7/8	56 1/2	58 7/8	82 11/16	95 3/4	67	68 1/4	71 15/16	71 7/8	73 5/8
December	91 13/16	71 1/4	61 13/16	58 3/16	59 1/4	83 7/8	100 1/2	66 3/8	66 3/4	71 15/16	76 1/4	74 3/16
Yearly average	97 1/16	79 1/8	67 3/4	57 1/16	62 3/8	66 13/16	85 3/4	89 3/4	71 1/8	70 13/16	72	74 5/8

[a] This table exhibits average cash prices for the past twelve years. The monthly prices are the means between the lowest and highest prices for each month, and the yearly prices are the averages of the monthly averages.

OATS.

The oats crop of the United States for 1902 was 987,842,712 bushels—the record yield—exceeding by 163,000,000 bushels the crop of 1895, which was the largest crop heretofore reported.

The acreage of oats for 1902 increased very slightly over 1901, but the high average yield per acre of 34.5 bushels, an increase of nearly 10 bushels, accounts for the largely increased production.

The world's oats crop reached 3,561,041,000 bushels and passed all records of production for previous years.

The visible supply on January 1 was 8,680,000 bushels, and steadily declined to 2,420,000 on July 1. The supply throughout the year was unusually low and was reduced to the lightest on record during the above period.

The range of prices of oats for the year 1902 was the highest since 1891, and the yearly average at Chicago was about 37 cents per bushel. Wholesale cash prices were well maintained and ruled high, advancing to the highest point in over twenty-five years and ruling at 56 cents at Chicago in July.

Oats crop of the countries named, 1898–1902.

Country.	1898.	1899.	1900.	1901.	1902.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
United States	730,907,000	796,178,000	809,126,000	736,809,000	987,843,000
Ontario	89,596,000	92,731,000	92,520,000	80,803,000	109,786,000
Manitoba	17,854,000	23,022,000	9,092,000	28,673,000	35,565,000
Rest of Canada	13,000,000	14,000,000	12,000,000	20,000,000	20,000,000
Total Canada	120,450,000	129,753,000	113,612,000	129,476,000	165,351,000
Total North America	851,357,000	925,931,000	922,738,000	866,285,000	1,153,194,000
Great Britain	122,669,000	118,363,000	118,467,000	113,576,000	134,493,000
Ireland	55,348,000	53,013,000	61,291,000	62,240,000	65,570,000
Total United Kingdom	178,017,000	171,376,000	179,758,000	175,816,000	200,063,000
Sweden	70,416,000	53,698,000	69,272,000	56,971,000	61,362,000
Denmark	41,474,000	37,074,000	40,323,000	37,409,000	37,000,000
Netherlands	16,618,000	16,061,000	17,296,000	16,000,000	13,000,000
Belgium	35,078,000	29,047,000	35,815,000	36,820,000	45,506,000
France	278,277,000	270,437,000	250,597,000	225,283,000	301,632,000
Spain	8,833,000	12,776,000	10,000,000	12,000,000	12,000,000
Italy	18,567,000	16,504,000	16,000,000	15,000,000	13,000,000
Germany	465,321,000	474,179,000	488,594,000	485,716,000	514,452,000
Austria	114,189,000	122,168,000	118,181,000	118,191,000	125,498,000
Hungary	78,708,000	81,217,000	70,946,000	68,083,000	82,673,000
Croatia-Slavonia	7,022,000	6,316,000	5,564,000	5,813,000	6,318,000
Total Austria-Hungary	199,919,000	209,701,000	194,691,000	192,087,000	214,489,000
Roumania	17,410,000	6,255,000	8,704,000	16,540,000	21,905,000
Bulgaria	10,662,000	5,775,000	6,000,000	8,000,000	10,000,000

Oats crop of the countries named, 1898–1902—Continued.

Country.	1898.	1899.	1900.	1901.	1902.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
Russia proper	559,920,000	839,639,000	744,037,000	527,576,000	807,409,000
Poland	55,515,000	56,463,000	51,235,000	56,150,000	63,043,000
North Caucasus	12,416,000	12,546,000	17,519,000	11,932,000	16,112,000
Total Russia in Europe	627,851,000	908,648,000	812,791,000	595,658,000	886,564,000
Total Europe	1,968,443,000	2,211,531,000	2,129,841,000	1,873,300,000	2,330,973,000
Siberia	51,258,000	76,853,000	34,918,000	21,569,000	34,078,000
Central Asia	8,423,000	9,804,000	5,987,000	6,870,000	9,433,000
Total Russia in Asia	59,681,000	86,657,000	40,905,000	28,439,000	43,511,000
Total Asia	59,681,000	86,657,000	40,905,000	28,439,000	43,511,000
Algeria	6,023,000	4,534,000	5,000,000	5,000,000	6,000,000
Cape Colony	1,493,000	1,868,000	1,750,000	1,750,000	1,750,000
Total Africa	7,516,000	6,402,000	6,750,000	6,750,000	7,750,000
West Australia	30,000	58,000	76,000	90,000	164,000
South Australia	211,000	314,000	225,000	378,000	484,000
Queensland	32,000	4,000	11,000	8,000	44,000
New South Wales	561,000	287,000	648,000	612,000	709,000
Victoria	4,961,000	5,697,000	6,309,000	9,884,000	6,937,000
Tasmania	1,137,000	2,343,000	1,184,000	1,451,000	1,756,000
New Zealand	10,015,000	17,032,000	16,840,000	19,687,000	15,519,000
Total Australasia	16,977,000	25,735,000	25,293,000	32,110,000	25,613,000

RECAPITULATION BY CONTINENTS.

North America	851,357,000	925,931,000	922,738,000	866,285,000	1,153,194,000
Europe	1,968,443,000	2,211,531,000	2,129,841,000	1,873,300,000	2,330,973,000
Asia	59,681,000	86,657,000	40,905,000	28,439,000	43,511,000
Africa	7,516,000	6,402,000	6,750,000	6,750,000	7,750,000
Australasia	16,977,000	25,735,000	25,293,000	32,110,000	25,613,000
Total	2,903,974,000	3,256,256,000	3,125,527,000	2,806,884,000	3,561,041,000

Visible supply of oats in the United States first of each month for ten years.[a]

Month.	1893–1894.	1894–1895.	1895–1896.	1896–1897.	1897–1898.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
July	4,805,000	3,134,000	9,007,000	14,120,000	12,912,000
August	2,627,000	2,135,000	4,653,000	10,384,000	9,604,000
September	4,846,000	9,380,000	4,673,000	11,410,000	13,784,000
October	5,324,000	10,765,000	4,124,000	13,821,000	15,573,000
November	7,252,000	12,738,000	8,020,000	17,217,000	20,096,000
December	6,602,000	12,332,000	10,248,000	17,995,000	19,768,000
January	5,602,000	11,864,000	10,446,000	19,538,000	16,148,000
February	5,371,000	10,508,000	11,446,000	19,978,000	20,245,000
March	4,089,000	9,227,000	12,211,000	20,832,000	17,925,000
April	3,938,000	8,905,000	14,326,000	20,672,000	15,609,000
May	3,761,000	7,823,000	13,426,000	16,138,000	14,402,000
June	3,401,000	11,284,000	13,460,000	12,878,000	10,421,000

Month.	1898–1899.	1899–1900.	1900–1901.	1901–1902.	1902–1903.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
July	8,716,000	10,262,000	12,716,000	15,275,000	2,420,000
August	4,971,000	6,885,000	9,364,000	7,808,000	2,988,000
September	7,360,000	10,973,000	13,853,000	10,603,000	5,159,000
October	9,286,000	13,127,000	17,140,000	14,445,000	11,241,000
November	11,352,000	13,254,000	20,528,000	12,899,000	10,661,000
December	9,460,000	11,789,000	18,136,000	10,109,000	10,401,000
January	10,893,000	12,004,000	15,861,000	8,680,000	8,794,000
February	13,231,000	11,876,000	16,175,000	8,537,000	8,727,000
March	14,782,000	12,449,000	16,800,000	8,207,000	12,437,000
April	15,725,000	14,176,000	15,823,000	6,606,000	12,432,000
May	13,971,000	13,845,000	16,824,000	5,010,000	9,992,000
June	13,661,000	12,301,000	14,989,000	4,571,000	....

[a] These figures represent stocks available at 62 of the principal points of accumulation east of the Rocky Mountains, stocks in Manitoba elevators, and stocks afloat on lakes and canals, as reported by Bradstreet's.

Condition of oats crop of United States, 1886–1902.

Year.	June.	July.	August.	September.	Year.	June.	July.	August.	September.	Year.	June.	July.	August.	September.
1886	95.9	88.8	87.4	90.9	1892 ...	88.5	87.2	86.2	78.9	1898 ...	98.0	92.8	84.2	79.0
1887	91.0	85.9	85.6	83.4	1893 ...	88.9	88.8	78.3	74.9	1899 ...	88.7	90.0	90.8	87.2
1888	95.4	95.2	91.7	87.2	1894 ...	87.0	77.7	76.5	77.8	1900 ...	91.7	85.5	85.0	82.9
1889	93.8	94.1	92.3	90.0	1895 ...	84.3	83.2	84.5	86.0	1901 ...	85.3	83.7	73.6	72.1
1890	89.8	81.6	70.1	64.4	1896 ...	98.8	96.3	77.3	74.0	1902 ...	90.6	92.1	89.4	87.2
1891	85.1	87.6	89.5	90.7	1897 ...	89.0	87.5	86.0	84.6					

Acreage, production, value, prices, exports, etc., of oats of the United States, 1866–1902.

Year.	Acreage.	Average yield per acre.	Production.	Average farm price per bushel, Dec. 1	Farm value Dec. 1.	Chicago cash price per bushel, No. 2. December. Low.	Chicago cash price per bushel, No. 2. December. High.	Chicago cash price per bushel, No. 2. May of following year. Low.	Chicago cash price per bushel, No. 2. May of following year. High.	Domestic exports, including oatmeal, fiscal years beginning July 1.[a]	Imports during fiscal years beginning July 1.[a]
	Acres.	*Bush.*	*Bushels.*	*Cts.*	*Dollars.*	*Cts.*	*Cts.*	*Cts.*	*Cts.*	*Bushels.*	*Bushels.*
1866.....	8,864,219	30.2	268,141,078	35.1	94,057,945	36	43	59	78	825,895	778,198
1867.....	10,746,416	25.9	278,698,000	44.5	123,902,556	52	57¼	......	......	122,554	780,798
1868.....	9,665,736	26.4	254,960,800	41.7	106,355,976	43	49½	56¾	62½	481,871	326,659
1869.....	9,461,441	30.5	288,334,000	38.0	109,521,734	40	44¾	46½	53½	121,517	2,266,785
1870.....	8,792,395	28.1	247,277,400	39.0	96,443,637	37¾	41	47¼	51	147,572	599,514
1871.....	8,365,809	30.6	255,743,000	36.2	92,591,359	30¾	33	34¾	42½	262,975	535,250
1872.....	9,000,769	30.2	271,747,000	29.9	81,303,518	23½	25¾	30	34	714,072	225,555
1873.....	9,751,700	27.7	270,340,000	34.6	93,474,161	34	40⅝	44	48½	812,873	191,802
1874.....	10,897,412	22.1	240,369,000	47.1	113,133,934	51¾	54½	57¼	64½	504,770	1,500,040
1875.....	11,915,075	29.7	354,317,500	32.0	113,441,491	29½	30⅛	28⅝	31½	1,466,228	121,547
1876.....	13,358,908	24.0	320,884,000	32.4	103,844,896	31¾	34½	37¼	45¾	2,854,128	41,597
1877.....	12,826,148	31.7	406,394,000	28.4	115,546,194	24⅛	27	23	27	3,715,479	21,391
1878.....	13,176,500	31.4	413,578,560	24.6	101,752,468	19⅝	20⅜	24⅜	30½	5,452,136	13,395
1879.....	12,683,500	28.7	363,761,320	33.1	120,533,294	32¾	36¾	29½	34⅞	766,366	489,576
1880.....	16,187,977	25.8	417,885,380	36.0	150,243,565	29⅙	33½	36¼	39½	402,904	64,412
1881.....	16,831,600	24.7	416,481,000	46.4	193,198,970	43½	46¾	48¾	56⅜	625,690	1,850,983
1882.....	18,494,691	26.4	488,250,610	37.5	182,978,022	34¾	41½	38¾	42¾	461,496	815,017
1883.....	20,324,962	28.1	571,302,400	32.7	187,040,264	29⅜	36⅛	30¾	34¼	3,274,622	121,069
1884.....	21,300,917	27.4	583,628,000	27.7	161,528,470	22½	25¼	34½	37	6,203,104	94,310
1885.....	22,783,630	27.6	629,409,000	28.5	179,631,860	27	29	26¼	29⅝	7,311,306	149,480
1886.....	23,658,474	26.4	624,134,000	29.8	186,137,930	25¾	27¼	25⅛	27¼	1,374,635	139,575
1887.....	25,920,906	25.4	659,618,000	30.4	200,699,790	28⅝	30⅞	32½	38	573,080	123,817
1888.....	26,998,282	26.0	701,735,000	27.8	195,424,240	25	26⅞	21⅝	23⅝	1,191,471	131,501
1889.....	27,462,316	27.4	751,515,000	22.9	171,781,008	20	21	24¾	30	15,107,238	153,232
1890.....	26,431,369	19.8	523,621,000	42.4	222,048,486	39⅞	43⅞	45¼	54	1,382,836	41,848
1891.....	25,581,861	28.9	738,394,000	31.5	232,312,267	31⅛	33⅝	28⅛	33½	10,586,644	47,782
1892.....	27,063,835	24.4	661,035,000	31.7	209,253,611	25⅝	31¼	28¾	32¼	2,700,793	49,433
1893.....	27,273,033	23.4	638,854,850	29.4	187,576,092	27½	29⅛	32½	36	6,290,229	31,759
1894.....	27,023,553	24.5	662,036,928	32.4	214,816,920	28¾	29⅜	27½	30¾	1,708,824	330,318
1895.....	27,878,406	29.6	824,443,537	19.9	163,655,068	16⅝	17½	18	19⅛	15,156,618	66,602
1896.....	27,565,985	25.7	707,346,404	18.7	132,485,033	16½	18¾	16⅞	18¾	37,725,083	131,204
1897.....	25,730,375	27.2	698,767,809	21.2	147,974,719	21	23⅞	26	32	73,880,307	25,093
1898.....	25,777,110	28.4	730,906,643	25.5	186,405,364	26	27¾	24	27¾	33,534,362	28,098
1899.....	26,341,380	30.2	796,177,713	24.9	198,167,975	22¼	23	21¼	23¾	45,048,857	54,576
1900.....	27,364,795	29.6	809,125,989	25.8	208,669,233	21¾	22¾	26	29⅜	42,268,931	32,107
1901.....	28,541,476	25.8	736,808,724	39.9	293,658,777	42	48¼	41	49½	13,277,612	38,978
1902.....	28,653,144	34.5	987,842,712	30.7	303,584,852	29¼	32	......	......	....	....

[a] In years 1866 to 1882, inclusive, oatmeal is not included.

Acreage, production, value, and distribution of oats of the United States in 1902, by States.

States and Territories.	Crop of 1902.			Stock on hand March 1, 1903.		Shipped out of county where grown.
	Acreage.	Production.	Value.			
	Acres.	*Bushels.*	*Dollars.*	*Bushels.*	*Per cent.*	*Bushels.*
Maine	116,461	4,541,979	2,043,891	1,362,594	30	45,420
New Hampshire	11,934	417,690	183,784	146,192	35	....
Vermont	77,780	3,111,200	1,337,816	1,213,368	39	....
Massachusetts	6,516	209,815	94,417	52,454	25	....
Rhode Island	1,722	62,336	26,804	24,934	40	....
Connecticut	10,181	351,244	144,010	80,786	23	....
New York	1,321,564	52,982,560	19,073,722	24,901,803	47	4,768,430
New Jersey	67,852	2,184,834	852,085	961,327	44	262,180
Pennsylvania	1,233,868	45,036,182	15,312,302	19,365,558	43	1,801,447
Delaware	5,024	113,542	47,688	22,708	20	2,271
Maryland	42,132	1,124,924	427,471	236,234	21	134,991
Virginia	222,074	3,886,295	1,632,244	1,127,026	29	233,178
North Carolina	238,143	3,024,416	1,542,452	604,883	20	90,732
South Carolina	216,541	2,836,687	1,673,645	255,302	9	85,101
Georgia	264,013	2,930,544	1,553,188	322,360	11	29,305
Florida	31,949	434,506	265,049	56,486	13	13,035
Alabama	212,857	2,320,141	1,276,078	232,014	10	46,403
Mississippi	117,419	1,808,253	922,209	198,908	11	....
Louisiana	34,932	530,966	265,483	53,097	10	....
Texas	896,869	20,807,361	10,195,607	2,496,883	12	1,456,515
Arkansas	252,420	5,048,400	2,069,844	1,211,616	24	201,935
Tennessee	186,071	3,219,028	1,351,992	869,138	27	354,093
West Virginia	85,614	2,448,560	1,003,910	710,082	29	48,971
Kentucky	259,396	5,758,591	2,073,093	2,073,093	36	287,930
Ohio	1,129,192	46,409,791	14,851,133	16,243,427	35	15,315,231
Michigan	1,011,031	40,340,137	13,312,245	14,522,449	36	10,488,436
Indiana	1,371,912	48,565,685	13,598,392	14,569,706	30	19,911,931
Illinois	4,070,303	153,450,423	42,966,118	55,242,152	36	76,725,211
Wisconsin	2,381,900	95,037,810	28,511,343	39,915,880	42	19,007,562
Minnesota	2,109,223	82,259,697	22,210,118	32,081,282	39	26,323,103
Iowa	4,063,138	124,738,337	31,184,584	43,658,418	35	18,710,751
Missouri	855,882	27,816,165	7,788,526	11,404,628	41	5,563,233
Kansas	941,168	31,529,128	9,458,738	12,611,651	40	9,143,447
Nebraska	1,795,422	62,121,601	15,530,400	24,848,640	40	24,227,424
South Dakota	692,553	24,100,844	6,989,245	10,845,380	45	3,374,118
North Dakota	766,599	29,437,402	7,948,099	14,424,327	49	4,709,984
Montana	159,154	6,668,553	2,400,679	2,734,107	41	2,267,308
Wyoming	36,179	1,302,444	651,222	416,782	32	221,415
Colorado	136,576	3,660,237	1,866,721	951,662	26	695,445
New Mexico	15,744	300,710	204,483	36,085	12	42,099
Arizona	1,798	56,997	42,748	13,679	24	....
Utah	44,970	1,596,435	750,324	526,824	33	127,715
Nevada	5,966	207,617	145,332	43,600	21	....
Idaho	81,064	3,412,794	1,638,141	819,071	24	1,262,734
Washington	154,006	7,115,077	3,486,388	2,063,372	29	1,423,015
Oregon	281,955	8,092,108	3,317,764	2,508,553	31	2,346,711
California	168,806	5,148,583	2,625,777	514,858	10	1,904,976
Oklahoma	277,240	13,252,072	4,505,704	3,843,101	29	3,578,059
Indian Territory	185,031	6,032,011	2,231,844	1,508,003	25	1,206,402
United States	28,653,144	987,842,712	303,584,852	364,926,483	36.9	258,438,248

Average yield per acre of oats in the United States, 1893–1902, by States.

States and Territories.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.
	Bush.	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*
Maine	36.3	33.5	40.1	40.0	31.0	36.0	35.0	37.5	35.0	39.0
New Hampshire	34.2	31.1	36.9	38.0	35.0	33.0	35.0	32.6	29.5	35.0
Vermont	36.4	32.9	43.8	40.5	33.0	38.0	37.0	34.9	33.0	40.0
Massachusetts	34.3	31.9	36.0	36.0	32.0	32.0	33.0	36.8	31.0	32.2
Rhode Island	28.2	30.0	32.4	30.0	32.0	27.0	26.0	30.9	29.4	36.2
Connecticut	25.0	25.8	31.9	29.0	29.0	28.2	28.0	31.0	28.7	34.5
New York	24.0	22.1	31.7	33.0	31.0	27.5	31.0	27.9	21.6	40.0
New Jersey	23.9	28.4	35.5	34.0	25.0	19.6	24.0	29.6	16.0	32.2
Pennsylvania	26.8	22.3	31.7	31.0	28.2	23.3	33.0	31.1	18.9	36.5
Delaware	25.4	19.0	19.1	29.0	22.0	22.0	20.0	21.0	18.5	22.6
Maryland	21.2	21.4	26.2	24.0	24.0	19.5	23.0	24.0	18.8	26.7
Virginia	17.5	12.0	17.7	18.5	12.0	16.1	14.0	14.8	14.9	17.5
North Carolina	14.1	10.9	15.1	12.0	13.0	14.3	12.0	13.9	14.4	12.7
South Carolina	11.8	12.0	15.2	11.0	15.5	17.2	12.0	15.5	15.8	13.1
Georgia	13.3	13.4	14.5	12.0	14.0	16.6	9.0	15.0	14.8	11.1
Florida	11.8	11.8	10.2	12.0	9.0	15.4	9.0	11.3	13.1	13.6
Alabama	14.2	13.2	14.9	14.0	13.0	16.8	10.0	14.4	14.5	10.9
Mississippi	15.5	13.0	15.7	13.0	14.0	18.5	10.0	14.0	15.2	15.4

Average yield per acre of oats in the United States, 1893–1902, by States—Continued.

States and Territories.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.
	Bush.	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*
Louisiana	16.0	22.3	15.0	10.0	18.0	18.1	18.0	18.0	13.4	15.2
Texas	25.1	32.7	20.7	20.0	25.0	29.7	25.0	38.0	16.3	23.2
Arkansas	19.3	18.5	25.4	16.0	17.0	22.8	19.0	22.2	12.3	20.0
Tennessee	18.4	11.6	22.5	16.5	10.0	18.7	14.0	16.6	17.5	17.3
West Virginia	23.5	18.5	23.4	24.0	20.0	19.5	23.0	21.0	18.7	28.6
Kentucky	22.2	21.0	26.2	21.0	18.0	22.4	18.0	21.3	19.7	22.2
Ohio	28.6	30.3	31.7	31.0	32.0	30.9	36.0	38.0	31.5	41.1
Michigan	26.0	26.1	23.9	30.0	26.0	32.8	34.0	36.7	29.0	39.9
Indiana	27.5	32.3	22.9	29.0	30.2	29.2	32.0	32.7	28.6	35.4
Illinois	27.2	36.1	24.4	28.0	32.0	29.0	38.0	38.0	28.2	37.7
Wisconsin	27.6	32.9	33.8	33.4	34.0	36.1	36.0	32.0	29.1	39.9
Minnesota	24.8	28.1	39.9	33.0	26.0	36.3	32.0	25.2	32.1	39.0
Iowa	24.8	25.6	46.2	27.5	30.0	34.0	33.0	34.0	29.8	30.7
Missouri	23.4	23.3	27.7	18.0	22.0	17.0	25.0	27.4	11.2	32.5
Kansas	18.5	17.9	17.9	13.0	24.0	18.0	29.0	31.6	18.6	33.5
Nebraska	15.0	12.6	23.8	19.0	31.0	32.1	30.0	21.8	19.8	34.6
South Dakota	21.5	7.6	25.3	27.5	22.0	26.8	26.0	21.5	28.8	34.8
North Dakota	21.9	25.9	32.1	22.0	23.0	30.7	30.0	10.3	32.6	38.4
Montana	34.0	40.1	35.8	47.0	42.0	40.6	38.0	39.0	42.0	41.9
Wyoming	24.0	30.4	41.0	32.0	35.0	31.2	30.0	34.2	41.0	36.0
Colorado	26.7	13.5	34.3	28.0	34.0	35.8	27.0	32.8	33.8	26.8
New Mexico	29.2	35.0	39.9	27.0	35.5	38.8	24.0	30.1	31.6	19.1
Arizona	......	......	......	......	......	......	......	......	35.0	31.7
Utah	27.9	33.0	33.8	38.0	35.0	39.7	34.0	35.9	33.0	35.5
Nevada	......	......	......	......	......	......	......	......	43.0	34.8
Idaho	33.1	38.5	35.2	42.0	36.3	43.6	34.0	36.6	38.3	42.1
Washington	39.7	36.5	40.3	36.0	48.0	41.9	37.0	34.4	47.5	46.2
Oregon	28.5	26.7	28.8	21.0	32.0	27.0	30.0	18.5	31.5	28.7
California	25.5	35.6	28.1	31.0	18.0	33.0	31.0	24.6	30.4	30.5
Oklahoma	......	......	......	......	......	......	......	......	20.7	47.8
Indian Territory	......	......	......	......	......	......	......	......	25.0	32.6
General average	23.4	24.5	29.6	25.7	27.2	28.4	30.2	29.6	25.8	34.5

Average yield of oats in certain countries, in bushels per acre, 1894–1901.

Year.	United States.	Russia.	Germany.	Austria.	Hungary.	France.	United Kingdom.
	(a)	(b)	(b)	(b)	(b)	(a)	(a)
1894	24.5	21.7	46.8	25.9	30.1	27.2	43.7
1895	29.6	19.9	43.2	26.2	29.6	27.5	39.5
1896	25.7	19.2	41.8	23.1	31.4	27.0	39.2
1897	27.2	15.7	39.9	21.5	24.3	23.1	40.1
1898	28.4	16.5	47.1	27.3	30.2	29.0	43.6
1899	30.2	23.6	48.0	30.2	33.3	27.8	41.8
1900	29.6	19.5	48.0	25.2	28.1	25.7	43.5
1901	34.5	14.0	44.5	25.6	28.1	23.5	40.6
Average	28.7	18.8	44.9	25.6	29.4	26.4	41.5

[a] Winchester bushels. [b] Bushels of 32 pounds.

Average value per acre of oats in the United States, based upon farm value December 1, 1893–1902, by States.

States and Territories.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.
Maine	$16.34	$14.74	$13.63	$12.40	$9.92	$12.24	$13.30	$14.25	$17.50	$17.55
New Hampshire	14.71	15.24	12.92	13.30	13.30	12.54	13.65	12.39	15.34	15.40
Vermont	15.29	16.78	14.37	12.56	10.56	13.30	13.69	12.56	16.50	17.20
Massachusetts	14.41	13.72	12.24	12.60	10.56	11.84	12.54	13.98	17.05	14.49
Rhode Island	12.13	14.10	12.64	9.30	10.88	9.99	9.62	11.74	15.88	15.57
Connecticut	10.00	11.09	9.89	8.99	9.86	10.15	10.36	10.85	15.50	14.14
New York	7.20	8.62	8.88	8.58	8.37	8.53	10.23	8.93	10.37	14.40
New Jersey	8.37	10.79	10.29	9.52	7.50	6.08	7.92	9.18	7.52	12.56
Pennsylvania	9.38	8.47	8.56	7.43	7.61	6.99	9.57	9.33	8.50	12.41
Delaware	9.65	6.65	5.54	6.09	5.06	6.60	5.00	6.30	8.33	9.49
Maryland	7.42	8.35	7.07	5.52	6.24	5.65	6.90	7.44	7.71	10.15
Virginia	6.13	4.44	5.31	4.81	3.48	4.67	4.62	5.48	6.26	7.35
North Carolina	6.20	4.80	5.74	4.20	4.81	5.29	4.92	6.26	7.34	6.48
South Carolina	6.25	6.36	7.45	5.28	6.98	7.74	5.64	7.44	9.80	7.73
Georgia	6.92	6.83	6.67	4.92	5.88	7.97	4.32	7.35	9.92	5.88

Average value per acre of oats in the United States, 1893–1902, by States—Continued.

States and Territories.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.
Florida	$6.49	$7.20	$6.63	$6.36	$4.77	$8.32	$4.50	$5.65	$9.43	$[illegible].36
Alabama	7.24	6.73	6.26	5.74	5.59	6.89	4.30	6.34	9.28	[illegible].00
Mississippi	7.28	6.11	6.12	5.72	6.16	7.77	5.00	6.44	9.58	7.45
Louisiana	7.04	10.48	5.40	3.40	6.84	6.88	7.20	7.20	8.04	7.6[illegible]
Texas	10.51	12.75	5.38	6.80	6.75	8.32	7.50	11.40	9.78	11.37
Arkansas	7.53	7.40	8.13	4.96	5.61	6.61	6.46	7.77	7.91	8.2[illegible]
Tennessee	5.70	5.11	6.08	4.29	2.80	5.21	4.18	5.81	7.87	7.27
West Virginia	8.93	7.21	7.49	6.72	6.00	5.85	8.65	7.14	8.94	11.72
Kentucky	7.55	7.56	6.81	5.04	4.86	6.05	5.76	6.60	8.08	7.9[illegible]
Ohio	8.58	9.39	6.97	5.27	6.40	7.42	9.00	9.88	12.28	13.15
Michigan	8.32	8.87	5.50	5.70	5.98	8.86	9.52	9.54	11.89	13.17
Indiana	7.70	9.69	4.58	4.64	5.74	6.72	7.36	7.52	10.87	9.91
Illinois	7.34	10.47	4.15	4.20	5.76	6.67	8.36	8.74	11.28	10.56
Wisconsin	7.45	9.87	6.03	5.85	6.46	8.66	8.28	7.36	11.35	11.97
Minnesota	6.45	8.43	5.59	4.95	4.94	7.62	7.04	6.65	10.91	10.52
Iowa	5.70	7.17	6.47	3.30	4.80	8.16	6.27	6.85	10.73	7.67
Missouri	5.85	6.76	4.99	3.06	4.18	3.91	6.00	6.30	4.82	9.10
Kansas	5.00	5.55	3.04	2.08	4.32	3.95	6.38	7.27	8.00	10.05
Nebraska	3.30	4.54	3.33	2.09	4.65	6.42	6.60	5.23	7.33	8.65
South Dakota	5.37	2.65	4.35	3.58	3.96	5.63	5.98	5.16	9.79	10.[illegible]
North Dakota	6.13	7.51	5.14	3.96	5.98	7.98	8.10	3.59	10.76	10.[illegible]
Montana	12.58	12.43	15.75	14.57	13.86	14.21	14.82	16.33	15.12	15.08
Wyoming	9.60	14.59	15.99	16.96	12.25	12.48	12.00	16.07	19.65	[illegible]
Colorado	9.88	6.21	9.60	8.40	10.83	14.68	11.34	14.10	16.90	13.[illegible]
New Mexico	14.89	17.50	17.96	10.80	14.56	15.91	10.56	14.45	18.96	12.95
Arizona	......	......	......	......	......	......	......	......	21.00	23.72
Utah	9.21	11.22	10.14	14.82	11.55	15.69	13.60	15.89	16.83	16.08
Nevada	......	......	......	......	......	......	......	......	30.10	24.16
Idaho	13.57	12.32	10.21	12.60	11.62	15.70	12.92	14.64	16.85	20.21
Washington	13.90	11.32	11.28	14.40	16.80	16.76	14.06	13.76	16.63	22.04
Oregon	10.55	7.48	7.78	6.93	11.20	10.80	12.30	7.59	10.71	11.77
California	9.69	15.66	10.96	13.64	8.82	16.50	14.57	11.32	13.38	15.55
Oklahoma	......	......	......	......	......	......	......	......	10.35	16.25
Indian Territory	......	......	......	......	......	......	......	......	11.50	12.66
General average	6.88	7.95	5.87	4.81	5.75	7.23	7.52	7.63	10.29	10.66

Average farm price of oats per bushel in the United States December 1, 1893–1902, by States.

States and Territories.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
Maine	45	44	34	31	32	34	38	38	50	45
New Hampshire	43	49	35	35	38	38	39	38	52	44
Vermont	42	51	33	31	32	35	37	36	50	43
Massachusetts	42	43	34	35	33	37	38	38	55	45
Rhode Island	43	47	39	31	34	37	37	38	54	43
Connecticut	40	43	31	31	34	36	37	35	54	41
New York	30	39	28	26	27	31	33	32	48	36
New Jersey	35	38	29	28	30	31	33	31	47	39
Pennsylvania	35	38	27	24	27	30	29	30	45	34
Delaware	38	35	29	21	23	30	25	30	45	42
Maryland	35	39	27	23	26	29	30	31	41	38
Virginia	35	37	30	26	29	29	33	37	42	42
North Carolina	44	44	38	35	37	37	41	45	51	51
South Carolina	53	53	49	48	45	45	47	48	62	59
Georgia	52	51	46	41	42	48	48	49	67	52
Florida	55	61	65	53	53	54	50	50	72	61
Alabama	51	51	42	41	43	41	43	44	64	55
Mississippi	47	47	39	44	44	42	50	46	63	51
Louisiana	44	47	36	34	38	38	40	40	60	56
Texas	42	39	26	34	27	28	30	30	60	49
Arkansas	39	40	32	31	33	29	34	35	57	45
Tennessee	31	35	27	26	28	28	32	35	45	42
West Virginia	38	39	32	28	30	30	35	34	43	43
Kentucky	34	36	26	24	27	27	32	31	41	33
Ohio	30	31	22	17	20	24	25	26	39	32
Michigan	32	34	23	19	23	27	28	26	41	33
Indiana	28	30	20	16	19	23	23	23	38	29
Illinois	27	29	17	15	18	23	22	23	40	28
Wisconsin	27	30	18	17	19	24	23	23	39	30
Minnesota	26	30	14	15	19	21	22	24	34	27
Iowa	23	28	14	12	16	24	19	20	36	25
Missouri	25	29	18	17	19	23	24	23	43	28
Kansas	27	31	17	16	18	22	22	23	43	30
Nebraska	22	36	14	11	15	20	22	24	37	25

Average farm price of oats per bushel in the United States December 1, 1893–1902, by States—Continued.

States and Territories.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
South Dakota	25	35	17	13	18	21	23	24	34	29
North Dakota	28	29	16	18	26	26	27	32	33	27
Montana	37	31	44	31	33	35	39	42	36	36
Wyoming	40	48	39	53	35	40	40	47	48	50
Colorado	37	46	28	30	32	41	42	43	50	51
New Mexico	51	50	45	40	41	41	44	48	60	68
Arizona	......	......	......	......	......	......	......	......	60	75
Utah	33	34	30	39	33	38	40	44	51	47
Nevada	......	......	......	......	......	......	......	......	70	70
Idaho	41	32	29	30	32	36	38	40	44	48
Washington	35	31	28	40	35	40	38	40	35	49
Oregon	37	28	27	33	35	40	41	41	34	41
California	38	44	39	44	49	50	47	46	44	51
Oklahoma	......	......	......	......	......	......	......	......	50	34
Indian Territory	......	......	......	......	......	......	......	......	46	37
General average	29.4	32.4	19.8	18.7	21.2	25.5	24.9	25.8	39.9	30.7

Transportation rates, average for oats in sacks, in cents per 100 pounds, St. Louis to New Orleans by river.

1882	20.00	1889	17.93	1896	14.55
1883	17.75	1890	15.66	1897	15.00
1884	14.00	1891	16.28	1898	10.00
1885	15.00	1892	16.87	1899	10.00
1886	16.00	1893	17.54	1900	10.00
1887	18.25	1894	17.14	1901	10.00
1888	15.00	1895	12.50	1902	10.00

CONTROL OF SMUT IN OATS.

Smut in oats was so destructive to that crop in the Northwest a few years ago that some of the sufferers from its ravages were inclined to give up growing oats altogether. But a new and powerful disinfectant had been introduced. This was formaldehyde, a derivative of wood alcohol. It was found almost at once that formaldehyde would kill many forms of microscopic animal and vegetable growth. This suggested its application for freeing cereals from smut fungi. Experiments were made at the North Dakota Experiment Station, which demonstrated that formaldehyde was a very satisfactory remedy for smut in oats. The spread of the information that relief had been found was very rapid and thousands of farmers immediately availed themselves of it. In the Dakotas, Minnesota, and Wisconsin the total saving was over $5,000,000, and probably more than thirty thousand families were directly benefited.

This is a valuable proof of the ready availability of successful new methods of cultivation and crop protection under the existing system of publishing the results of investigation and experiment.

Wholesale prices of oats per bushel in leading cities of the United States, 1897–1902.

Date.	New York.		Baltimore.		Cincinnati.		Chicago.		Milwaukee.		Duluth.		Detroit.		San Francisco.	
	No. 2, mixed.		No. 2, mixed.		No. 2, mixed.		No. 2.		No. 2, white.		No. 2.		No. 2, white.		No. 1, white (per cwt.).	
	Low.	High.	Low.	High.	Low.	High.	Low.	High.	Low.	High.	Low.	High.	Low.	High.	Low.	High.
1897.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.		
January	21½	22½	21	22	18½	20	15¾	17	18	19½	16¼	18¾	19¼	20	$1.27½	$1.30
February	21	21¾	21	22	16¾	19½	15⅝	16½	16½	19½	16¼	17¼	19¾	20	1.27½	1.30
March	21½	22¼	21	23½	17½	21	16	17	17½	20¾	16½	17¼	20	21½	1.20	1.30
April	22	23½	23½	24	20	21½	17	18¼	18½	22½	16½	19	21¼	22½	1.20	1.22½
May	21½	23¼	23½	26	19½	22	16⅞	18¾	20	23¼	18½	22	22	24	1.22½	1.25
June	21½	23	23	25½	19	22	17½	18½	20	23	20	21¼	21¼	23½	1.20	1.25
July	21½	22½	23	24	19½	21½	17	18¾	20½	22½	19¾	21¼	21¼	24½	1.17½	1.22½
August	21¼	22¼	20	24	17	21	16¼	20⅛	20	23	18	22½	19¾	23½	1.20	1.25
September	23¼	25	21	23½	19½	21¾	18⅞	20¾	21	23½	20⅝	23	22¾	23¼	1.27½	1.30
October	22½	24½	22¾	23½	20	21¾	17¾	19¾	21	22¾	20¼	21½	22	23¼	1.17½	1.27½
November	24½	26½	23	27	20½	24½	19½	22¼	22¼	24½	21½	22¾	22	26	1.15	1.20
December	26¼	29¼	26½	28	23¼	25	21	23⅞	23	26	22	25½	24½	26	1.12½	1.17½
1898.																
January	28¼	29¼	27½	28	24	26	21½	24	23¾	25¼	23½	25	24½	26¾	1.15	1.22½
February	29	32	28	33	25½	28¾	24	27	24¾	29	24	28	26½	32¼	1.20	1.22½
March	30	32	30	32½	27½	29	21⅞	26¾	28	30	24¾	27½	29¼	30¾	1.20	1.32½
April	29¾	35½	30	35	28	31	25	31⅞	28	33	25	32¾	30¼	32½	1.32½	1.42½
May	32½	36	33	36	29	34½	26	32	28¾	34½	27	33¼	30¼	36¼	1.40	1.42½
June	27¾	32½	27½	33	25½	28	21	26½	25½	29½	22½	28	27	30¼	1.35	1.37½
July	25½	28	26½	32	23½	27	20¾	26	24	29	23	25	26¼	29¾	1.30	1.37½
August	26¾	28½	24	33	21½	24¼	20¼	22½	23	28¼	20	24	24¼	27¼	1.20	1.32½
September	25½	26¾	24	26	22	25	20¼	22⅜	22¼	25½	21	23¾	23¼	25¼	1.17½	1.27½
October	25¾	29½	25½	28	23	26½	21½	25	24	27¾	23	25½	24¾	29	1.22½	1.27½
November	29	30¾	27½	32	26½	29	24¼	27¾	27	30	25	27	25½	29½	1.22½	1.27½
December	30¾	33¾	31½	32½	28	30	26	27¾	22¾	30	26¾	30	29¼	30¾	1.27½	1.32½
1899.																
January	33	35	32	33½	28½	31	26¼	27¾	28¾	31¼	28¾	30½	30½	33	$1.30	$1.37½
February	34¼	35½	33	35	28¾	31½	26¾	28¼	29½	31½	28¼	30	32½	33	1.32	1.40
March	32	35¼	32	34	28½	31	25¼	27¾	28¾	30¾	25¾	29¼	31	32¾	1.35	1.42½
April	32½	33½	32	33	29	30½	26⅜	27¼	29½	31	27¼	28	32¼	33	1.37½	1.45
May	31	32½	29½	33	27¼	29½	24	27¼	26¼	31	26½	28	30¼	37¼	1.40	1.45
June	30½	31½	29½	31	27	29	24¼	26¼	27¼	29¼	26⅛	28½	28¾	30¼	1.37½	1.42½
July	28	30½	28½	31	22	28½	19¾	25	24	28¾	22½	26¼	25½	30	1.22½	1.27½
August	26	27½	24½	29	21½	22½	19¼	22	23	25½	19½	23¼	23½	24	1.22½	1.27½
September	25¾	29	25	28	22⅛	25½	21	23¼	22¾	26	20¼	24	23¾	28½	1.27½	1.30
October	28½	29¼	27½	29	24¾	26	22	23½	24¾	26	22¼	24¼	26	27½	1.25	1.30
November	28½	30	27½	29½	25¼	26½	22½	24	25½	26½	22½	23¾	27	28	1.25	1.30
December	28½	30	28	29½	25½	26¾	22¼	23	24¾	25½	22½	23¼	26½	27½	1.22½	1.27½

Wholesale prices of oats per bushel in leading cities of the United States, 1897-1902—Continued.

Date.	New York.		Baltimore.		Cincinnati.		Chicago.		Milwaukee.		Duluth.		Detroit.		San Francisco.	
	No. 2, mixed.		No. 2, mixed.		No. 2, mixed.		No. 2.		No. 2, white.		No. 2.		No. 2, white.		No. 1, white (per cwt.).	
	Low.	High.	Low.	High.	Low.	High.	Low.	High.	Low.	High.	Low.	High.	Low.	High.	Low.	High.
1900.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*		
January	29	29¾	28	29½	25¼	26½	22½	23	25	25¾	23	24	26¼	28½	$1.25	$1.30
February	29	29½	28¾	29½	25¼	26	22½	23¾	25½	26	24	24	27½	28½	1.25	1.25
March	28½	29½	28	29½	25¼	26½	23	24½	25	26¾	24	24	27¼	28½	1.25	1.26¼
April	27½	29½	27¾	29¼	26	28	23	25¼	26½	29	24	24½	28¼	29	1.25	1.26¼
May	26	28	26½	28¼	24¼	26¼	21¼	23¾	24	27½	23	24½	27	28½	1.22½	1.25
June	26	29¾	26	29	24	27	21¾	26¼	24	28½	23	28	26	29¼	1.22½	1.25
July	26½	29	27	28½	25	28	21½	24¾	25¾	28½	23¾	28	28	28½	1.25	1.30
August	25½	26½	24	27	21	25	21	22⅝	24½	27	23¼	24½	24½	28	1.27½	1.30
September	24¾	25½	24½	25¾	22¼	23½	21⅛	22¼	24¾	26	22½	23¾	24¾	26	1.27½	1.27½
October	25	26	24¾	25½	23	24	21⅜	22⅝	24¾	26	23¼	24	25¼	26	1.30	1.32½
November	25½	26¾	24¾	26	23	25	21¾	22½	24¾	26¼	23¼	23¼	24	26½	1.35	1.35
December	26½	28½	26	29	24	25½	21¾	22¾	25½	26¼	23½	24¾	27	28	1.35	1.40
1901.																
January	28¼	31	28	29	25	27½	23¼	24¼	25½	27½	25¼	26¼	28	28½	1.17½	1.45
February	30	31	28	30	26¾	28	24⅛	25½	27	28¼	26¼	26¾	28½	30	1.20	1.42½
March	30½	31½	29¾	31	27½	28	24¾	26½	27½	28¾	25¼	27¼	29	29¾	1.20	1.45
April	30¾	32	30½	32	28	29	25½	27½	27¾	30½	27	27¼	30	31	1.25	1.50
May	32¼	34	31	32	30	32	27⅞	31	29	30½	27¼	29¼	30½	32½	1.30	1.45
June	32	33	31½	32½	29½	30½	27	28¾	28¾	30½	27¼	28¼	30	31½	1.40	1.55
July	33⅛	41½	31½	42	31½	42	27½	39	30¾	41½	27¼	36¼	31½	40½	1.15	1.40
August	38	40½	37¼	42½	37	38	33½	37½	36¾	39½	34⅞	37½	54½	60½	1.10	1.35
September	38	39½	37½	38½	36	38	33⅝	36¾	36¼	38¾	35⅛	37½	36¼	39½	1.10	1.30
October	38	42	38	41½	38	39	34½	37¾	36	39½	35¼	37⅛	38½	40½	1.02½	1.30
November	42½	49	41	49	40	46	37⅛	44⅛	39½	46	36⅞	43¼	41½	48½	1.10	1.30
December	49	52	48½	53	47	50¾	42	48¼	46½	48¾	42¾	46⅞	48½	51	1.20	1.42½
1902.																
January	46½	53	48	52	46	50	38⅛	46½	43	49	40⅜	47⅛	45	50½	1.25	1.40
February	48	50	47	49½	46	48	40¾	44¼	42	46½	38⅝	43¼	46	47½	1.27½	1.42½
March	46¾	52	47½	49	45½	47	40¼	45½	42	46½	40	43	46	48¼	1.25	1.40
April	46½	49½	47½	49	44	46½	41	44½	42	47	40	46⅛	46	48½	1.27½	1.45
May	45½	48	47½	48½	44	46	41	49½	43	45½	42⅛	45⅝	46	48½	1.35	1.50
June	44½	55	47½	55	43	52	39	48½	42	54	28¾	31	46½	57	1.35	1.50
July	55	64¾	54	60	32½	57	30	56	42	61	30½	34½	57	61	1.20	1.35
August	34½	65	31	59	27	31	25	31	32	61	27½	30	34¾	60	1.15	1.30
September	32	35	29	32	28½	31½	26⅛	27¼	30	34	29	31½	36¼	39½	1.17½	1.30
October	33	34½	29½	33½	30	32	27¼	30	30	33½	29½	32	38½	41¼	1.15	1.32½
November	34	36	32½	35½	29¾	34	27¾	29½	29	33½	28½	32	41¼	48	1.20	1.35
December	36	38¼	35½	40	33	39	29¼	32	30	34	31	32	48½	51	1.25	1.40

Monthly average prices of oats in Chicago.[a]

[Cents per bushel.]

Month.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.
January	43¾	29¼	31	28¼	28⅞	18¼	16⅞	22¾	27	22¾	23⅞	42 3/16
February	46⅛	29¾	30¾	28¾	28¼	19 15/16	16⅛	25⅛	27⅛	23⅛	24 13/16	42½
March	50⅝	28½	29 15/16	30 1/16	29⅜	19¼	16⅛	25 13/16	26¼	23 3/16	25⅜	42¼
April	53¼	29⅛	27 15/16	32⅛	29 1/16	19⅛	17⅛	28 7/16	25 13/16	24½	26½	42¾
May	49⅜	31	30½	31½	29 3/16	18 13/16	17 13/16	29	25⅜	27¼	29 7/16	45¼
June	39⅛	31¾	29⅝	42	28 3/16	16⅞	18⅛	23¾	25¼	24	27⅞	43¾
July	33⅛	31⅞	26 3/16	38 3/16	23⅞	16¾	17 9/16	23⅜	22 7/16	23⅛	33¼	43
August	29½	32¾	23⅛	30⅞	20⅞	17⅛	18 3/16	21⅜	20⅝	21 13/16	35½	28
September	28¼	33⅛	26 5/16	29 5/16	19¼	16	19 13/16	21 5/16	22⅛	21 11/16	35 3/16	26 13/16
October	28 3/16	30¼	27⅛	28⅛	18¼	18 5/16	18¾	23¼	22¾	22	36⅛	28⅝
November	32¼	31¼	28¼	29⅛	18½	18⅝	20⅞	26	23¼	22⅛	40⅝	28⅝
December	32 3/16	30¾	28⅛	29½	17 5/16	17⅝	22 7/16	26⅞	22⅝	22¼	45⅛	30⅜
Yearly average	38⅞	30 13/16	28¼	31¾	24¼	18 1/16	18¼	24¾	24⅜	23⅛	32	37 1/16

[a] This table exhibits average cash prices for the past twelve years. The monthly prices are the means between the lowest and highest prices for each month, and the yearly prices are the averages of the monthly averages.

BARLEY.

The barley crop of the United States and the world for 1902 are record breaking, as it will be noted is the case with nearly all the principal cereal crops for the past year.

The production in the United States was 134,954,023 bushels, and for the world 1,177,656,000 bushels. The general average yield per acre in the United States of 29 bushels for 1902 was exceptionally high.

Wholesale prices show a wide monthly range, but were generally higher than in previous years.

Prices in Chicago ranged from 35 cents in October and November to 73 cents in July.

Barley crop of the countries named, 1898–1902.

Country.	1898.	1899.	1900.	1901.	1902.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
United States	55,792,000	73,382,000	58,926,000	109,933,000	134,954,000
Ontario	13,063,000	15,298,000	17,443,000	17,289,000	22,580,000
Manitoba	4,413,000	5,549,000	3,032,000	6,742,000	12,222,000
Rest of Canada	2,900,000	2,950,000	2,500,000	3,500,000	4,000,000
Total Canada	20,376,000	23,797,000	22,975,000	27,531,000	38,802,000
Mexico	13,401,000	10,735,000	10,529,000	9,000,000	9,000,000
Total North America	89,569,000	107,914,000	92,430,000	146,464,000	182,756,000
Great Britain	70,197,000	68,850,000	64,278,000	63,033,000	68,590,000
Ireland	6,889,000	7,024,000	6,485,000	6,808,000	8,276,000
Total United Kingdom	77,086,000	75,874,000	70,763,000	69,841,000	76,866,000
Sweden	14,805,000	11,691,000	14,786,000	13,368,000	12,988,000
Denmark	21,868,000	21,694,000	22,826,000	22,283,000	24,000,000
Netherlands	3,822,000	3,971,000	4,584,000	3,700,000	3,000,000
Belgium	3,860,000	3,902,000	4,754,000	4,650,000	4,805,000
France	46,878,000	45,306,000	40,847,000	38,857,000	45,771,000
Spain	57,668,000	53,428,000	55,000,000	60,000,000	62,000,000
Italy	8,900,000	8,000,000	7,000,000	8,000,000	6,000,000
Germany	132,019,000	137,048,000	137,889,000	152,537,000	142,392,000
Austria	63,486,000	73,226,000	61,480,000	67,091,000	73,819,000
Hungary	57,334,000	61,587,000	53,879,000	50,069,000	62,464,000
Croatia-Slavonia	3,540,000	2,735,000	3,132,000	3,049,000	3,000,000
Total Austria-Hungary	124,360,000	137,548,000	118,491,000	120,209,000	139,283,000
Roumania	29,656,000	4,548,000	14,618,000	24,222,000	24,671,000
Bulgaria	12,204,000	6,650,000	10,000,000	9,500,000	11,000,000

Barley crop of the countries named, 1898–1902—Continued.

Country.	1898.	1899.	1900.	1901.	1902.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
Russia proper	254,702,000	179,850,000	187,230,000	189,435,000	273,608,000
Poland	19,480,000	20,090,000	18,415,000	20,640,000	22,185,000
North Caucasus	25,107,000	18,144,000	27,105,000	25,685,000	35,530,000
Total Russia in Europe	299,289,000	218,084,000	232,750,000	235,760,000	331,323,000
Total Europe	832,415,000	727,739,000	734,308,000	762,927,000	884,099,000
Siberia	4,904,000	5,955,000	2,969,000	2,003,000	2,628,000
Central Asia	2,728,000	2,870,000	1,262,000	2,154,000	3,008,000
Total Russia in Asia	7,632,000	8,825,000	4,231,000	4,157,000	5,636,000
Japan	45,629,000	43,037,000	44,328,000	44,000,000	44,000,000
Total Asia	53,261,000	51,862,000	48,559,000	48,157,000	49,636,000
Algeria	41,467,000	33,088,000	35,000,000	35,000,000	47,000,000
Tunis	11,000,000	7,000,000	7,000,000	8,000,000	11,000,000
Cape Colony	937,000	857,000	800,000	700,000	800,000
Total Africa	53,404,000	40,945,000	42,800,000	43,700,000	58,800,000
West Australia	24,000	30,000	58,000	30,000	37,000
South Australia	167,000	241,000	195,000	218,000	251,000
Queensland	52,000	36,000	122,000	131,000	286,000
New South Wales	103,000	66,000	138,000	117,000	118,000
Victoria	782,000	1,148,000	1,512,000	1,254,000	718,000
Tasmania	72,000	190,000	70,000	70,000	72,000
New Zealand	732,000	1,731,000	1,635,000	1,060,000	883,000
Total Australasia	1,932,000	3,442,000	3,730,000	2,880,000	2,365,000
Grand total	1,030,581,000	931,902,000	921,827,000	1,004,128,000	1,177,656,000

Visible supply of barley in the United States 1st of each month for ten years.[a]

Month.	1893–1894.	1894–1895.	1895–1896.	1896–1897.	1897–1898.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
July	549,000	383,000	166,000	805,000	1,574,000
August	628,000	200,000	48,000	771,000	1,051,000
September	464,000	774,000	121,000	790,000	1,578,000
October	1,002,000	2,401,000	1,956,000	2,292,000	2,630,000
November	3,242,000	4,433,000	3,645,000	6,032,000	4,267,000
December	4,324,000	4,455,000	5,674,000	5,500,000	6,318,000
January	3,098,000	3,781,000	4,017,000	4,501,000	5,115,000
February	2,495,000	2,481,000	2,970,000	4,183,000	3,455,000
March	1,662,000	1,974,000	2,081,000	4,124,000	2,571,000
April	1,087,000	1,274,000	1,298,000	3,514,000	1,492,000
May	620,000	565,000	1,253,000	2,816,000	1,159,000
June	399,000	162,000	957,000	1,819,000	815,000

Month.	1898–1899.	1899–1900.	1900–1901.	1901–1902.	1902–1903.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
July	587,000	1,059,000	1,038,000	528,000	847,000
August	584,000	694,000	702,000	335,000	217,000
September	548,000	1,055,000	1,158,000	956,000	419,000
October	2,125,000	1,739,000	2,779,000	3,610,000	2,460,000
November	3,777,000	3,925,000	5,396,000	4,813,000	5,064,000
December	4,406,000	4,695,000	6,053,000	5,416,000	5,680,000
January	4,372,000	3,122,000	5,395,000	4,580,000	4,389,000
February	4,017,000	2,303,000	4,331,000	5,244,000	3,843,000
March	3,067,000	2,138,000	3,903,000	5,065,000	3,107,000
April	2,626,000	1,712,000	2,879,000	4,075,000	2,426,000
May	1,913,000	1,720,000	1,761,000	2,146,000	1,493,000
June	1,555,000	1,267,000	1,351,000	1,836,000	....

[a] These figures represent stocks available at 62 of the principal points of accumulation east of the Rocky Mountains, stocks in Manitoba elevators, and stocks afloat on lakes and canals as reported by Bradstreet's.

Condition of barley crop of United States, monthly, 1887–1902.

Year.	June.	July.	August.	September.	Year.	June.	July.	August.	September.
1887	87.0	82.8	86.2	83.0	1895	90.3	91.9	87.2	87.6
1888	88.8	91.0	89.4	86.9	1896	98.0	88.1	82.9	83.1
1889	95.6	91.9	90.6	88.9	1897	87.4	88.5	87.5	86.4
1890	86.4	88.3	82.8	78.6	1898	78.8	85.7	79.3	79.2
1891	90.3	90.9	93.8	94.3	1899	91.4	92.0	93.6	86.7
1892	92.1	92.0	91.1	87.4	1900	86.2	76.3	71.6	70.7
1893	88.3	88.8	84.6	83.8	1901	98.8	91.3	86.9	85.8
1894	82.2	76.8	69.8	71.5	1902	93.6	93.7	90.2	89.7

Acreage, production, value, prices, exports, etc., of barley of the United States, 1866–1902.

Year.	Acreage.	Average yield per acre.	Production.	Average farm price per bushel Dec. 1.	Farm value Dec. 1.	Chicago cash price per bushel, No. 2. December. Low.	December. High.	May of following year. Low.	May of following year. High.	Domestic exports, fiscal years beginning July 1.	Imports, fiscal years beginning July 1.
	Acres.	*Bush.*	*Bushels.*	*Cts.*	*Dollars.*	*Cts.*	*Cts.*	*Cts.*	*Cts.*	*Bushels.*	*Bushels.*
1866	492,532	22.9	11,283,807	70.2	7,916,342	59	70	85	100	....	3,247,250
1867	1,131,217	22.7	25,727,000	70.1	18,027,746	150	180	227	250	9,810	3,783,966
1868	937,498	24.4	22,896,100	109.0	24,948,127	140	170	149	175	59,077	5,069,880
1869	1,025,795	27.9	28,652,200	70.8	20,298,164	74	85	50	62	255,490	6,727,597
1870	1,108,924	23.7	26,295,400	79.1	20,792,213	68	80	72	95	340,093	4,866,700
1871	1,113,735	24.0	26,718,500	75.8	20,264,015	55½	64	55	71	86,891	5,565,591
1872	1,397,082	19.2	26,846,400	68.6	18,415,839	60	70	71	85	482,410	4,244,751
1873	1,387,106	23.1	32,044,491	86.7	27,794,229	132	158	130	155	320,399	4,891,189
1874	1,580,626	20.6	32,552,500	86.0	27,997,824	120	129½	115	137	91,118	6,255,063
1875	1,789,902	20.6	36,908,600	74.1	27,367,522	81	88	62½	72½	317,781	10,285,957
1876	1,766,511	21.9	38,710,500	63.0	24,402,691	63¾	68½	80	85	1,186,129	6,702,965
1877	1,614,654	21.3	34,441,400	62.8	21,629,130	56¼	64	46½	52½	3,921,501	6,764,228
1878	1,790,400	23.6	42,245,630	57.9	24,454,301	91	100	64	73	715,536	5,720,979
1879	1,680,700	24.0	40,283,100	58.9	23,714,444	86	92	75	80	1,128,923	7,135,258
1880	1,843,329	24.5	45,165,346	66.6	30,090,742	100	120	95	105	885,246	9,528,616
1881	1,967,510	20.9	41,161,330	82.3	33,862,513	101	107	100	100	205,930	12,182,722
1882	2,272,103	21.5	48,953,926	62.9	30,768,015	79	82	80	80	433,005	10,050,687
1883	2,379,009	21.1	50,136,097	58.7	29,420,423	62	67	65	74	724,955	8,596,122
1884	2,608,818	23.5	61,203,000	48.7	29,779,170	53	58	65	65	629,130	9,986,507
1885	2,729,359	21.4	58,360,000	56.3	32,867,696	62	65	58	60	252,183	10,197,115
1886	2,652,957	22.4	59,428,000	53.6	31,840,510	51	54	57	57	1,305,300	10,355,594
1887	2,901,953	19.6	56,812,000	51.9	29,464,390	80	80	69	77	550,884	10,831,461
1888	2,996,382	21.3	63,884,000	59.0	37,672,032	......	......	......	......	1,440,321	11,368,414
1889	3,220,834	24.3	78,332,976	41.6	32,614,271	58	58	......	......	1,408,311	11,332,545
1890	3,135,302	21.4	67,168,344	62.7	42,140,502	......	......	......	......	973,062	5,078,733
1891	3,352,579	25.9	86,839,153	52.4	45,470,342	......	......	......	......	2,800,075	3,146,328
1892	3,400,361	23.6	80,096,762	47.5	38,026,062	65	67	65	65	3,035,267	1,970,129
1893	3,220,371	21.7	69,869,495	41.1	28,729,386	52	54	55	60	5,219,405	791,061
1894	3,170,602	19.4	61,400,465	44.2	27,134,127	53½	55½	51	52	1,563,754	2,116,816
1895	3,299,973	26.4	87,072,744	33.7	29,312,413	33	40	25	36	7,680,331	837,384
1896	2,950,539	23.6	69,695,223	32.3	22,491,241	a 22	37	a 24½	35	20,030,301	1,271,787
1897	2,719,116	24.5	66,685,127	37.7	25,142,139	a 25½	42	a 36	53	11,237,077	124,804
1898	2,583,125	21.6	55,792,257	41.3	23,064,359	a 40	50½	a 36	42	2,267,400	110,475
1899	2,878,229	25.5	73,381,563	40.3	29,594,254	a 35	45	a 36	44	23,661,662	189,757
1900	2,894,282	20.4	58,925,833	40.8	24,075,271	a 37	61	a 37	57	6,293,207	171,004
1901	4,295,744	25.6	109,932,924	45.2	49,705,163	a 56	63	a 64	72	8,714,268	57,406
1902	4,661,063	29.0	134,954,023	45.9	61,898,634	a 36	70	......	......	....	....

a Chicago prices from 1895 are for No. 3 grade.

Acreage, production, and value of barley in the United States in 1902, by States.

States and Territories.	Acreage.	Average yield per acre.	Production.	Average farm price, Dec. 1.	Average value per acre, Dec. 1.	Farm value, Dec. 1.
	Acres.	*Bushels.*	*Bushels.*	*Cents.*	*Dollars.*	*Dollars.*
Maine	8,571	29.4	251,987	68	19.99	171,351
New Hampshire	1,759	21.2	37,291	75	15.90	27,968
Vermont	12,954	29.7	384,734	61	18.12	234,688
New York	117,867	28.5	3,359,210	55	15.68	1,847,566
Pennsylvania	8,966	21.0	188,286	54	11.34	101,674

Acreage, production, and value of barley in the United States in 1902, by States—Cont'd.

States and Territories.	Acreage.	Average yield per acre.	Production.	Average farm price, Dec. 1.	Average value per acre, Dec. 1.	Farm value, Dec. 1.
	Acres.	*Bushels.*	*Bushels.*	*Cents.*	*Dollars.*	*Dollars.*
Maryland	1,560	27.0	42,120	49	13.23	20,639
Virginia	2,655	18.3	48,586	54	9.88	26,236
Texas	4,724	21.3	100,621	72	15.34	72,447
Tennessee	1,479	16.0	23,664	61	9.76	14,435
Kentucky	986	25.9	25,537	56	14.50	14,301
Ohio	31,703	32.3	1,024,007	49	15.83	501,763
Michigan	38,681	28.6	1,106,277	52	14.87	575,264
Indiana	11,118	28.0	311,304	46	12.88	143,200
Illinois	22,704	28.6	649,334	44	12.58	285,707
Wisconsin	488,421	33.8	16,508,630	46	15.55	7,593,970
Minnesota	907,561	28.6	25,956,245	37	10.58	9,603,811
Iowa	513,499	26.3	13,505,024	36	9.47	4,861,809
Missouri	1,670	25.0	41,750	55	13.75	22,962
Kansas	138,939	16.0	2,223,024	38	6.08	844,749
Nebraska	65,378	31.1	2,033,256	33	10.26	670,974
South Dakota	305,745	29.2	8,927,754	38	11.10	3,392,547
North Dakota	501,948	31.6	15,861,557	36	11.38	5,710,161
Montana	17,874	37.0	661,338	51	18.87	337,282
Wyoming	1,324	24.4	32,306	75	18.30	24,230
Colorado	21,019	26.3	552,800	60	15.78	331,680
New Mexico	1,097	16.1	17,662	71	11.43	12,540
Arizona	14,342	25.2	361,418	91	22.93	328,890
Utah	8,466	32.1	271,759	59	18.94	160,338
Nevada	7,238	34.3	248,263	80	27.44	198,610
Idaho	37,731	46.3	1,746,945	53	24.54	925,881
Washington	140,075	43.7	6,121,278	46	20.10	2,815,788
Oregon	62,324	31.9	1,988,136	52	16.59	1,033,831
California	1,144,274	26.0	29,751,124	63	16.38	18,743,208
Oklahoma	16,411	36.0	590,796	42	15.12	248,134
United States	4,661,063	29.0	134,954,023	45.9	13.28	61,898,634

Average yield per acre of barley in the United States, 1893–1902, by States.

States and Territories.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.
	Bush.	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*
Maine	26.1	26.1	32.4	30.6	25.0	27.0	29.0	27.4	27.5	29.4
New Hampshire	25.3	24.4	25.6	29.3	22.5	23.5	25.0	22.7	21.5	21.2
Vermont	27.5	27.9	33.2	33.0	28.5	30.0	31.0	29.1	29.6	29.7
Massachusetts	25.3	21.7	22.5	30.0	34.5	24.5	30.0	25.8	......	......
Rhode Island	25.2	30.0	23.5	29.0	28.0	28.0	29.0	28.0	......	......
New York	20.3	17.5	22.9	23.2	25.0	25.2	24.0	22.0	14.0	28.5
Pennsylvania	19.0	16.6	20.2	17.2	24.5	19.4	21.0	19.0	17.2	21.0
Maryland									18.0	27.0
Virginia	......	......	......	......	......	......	......	......	24.9	18.3
Texas	14.5	15.3	21.6	12.0	25.0	20.0	18.0	24.6	13.5	21.3
Tennessee	15.1	13.8	23.1	14.0	18.0	18.0	11.0	11.7	16.8	16.0
Kentucky	17.0	28.7	33.3	14.8	20.0	16.0	21.0	28.6	19.4	25.9
Ohio	22.7	28.5	28.2	20.2	28.5	28.7	28.0	27.0	24.9	32.3
Michigan	16.4	20.6	18.1	22.3	21.5	25.2	24.0	23.9	22.8	28.6
Indiana	19.9	20.7	15.0	20.3	19.0	23.4	25.0	24.6	25.4	28.0
Illinois	23.2	23.5	20.0	23.7	25.0	27.3	29.0	25.6	24.5	28.6
Wisconsin	24.0	28.6	29.3	27.4	28.0	29.1	30.0	25.5	27.2	33.8
Minnesota	22.1	23.5	36.0	27.2	25.5	28.4	25.0	22.4	25.8	28.6
Iowa	22.6	15.5	28.0	26.3	24.0	26.0	26.0	26.4	23.6	26.3
Missouri	20.0	14.0	15.3	17.5	19.0	20.0	18.0	20.8	16.5	25.0
Kansas	8.1	8.8	14.4	4.6	17.5	28.0	17.0	21.5	15.9	16.0
Nebraska	12.0	5.7	28.4	19.9	22.0	27.1	26.0	17.6	16.0	31.1
South Dakota	15.4	14.7	19.5	28.5	20.0	23.0	23.0	14.3	22.4	29.2
North Dakota	15.2	20.1	30.4	16.1	22.5	26.4	24.0	8.2	28.2	31.6
Montana	30.1	22.5	25.0	25.0	38.0	36.0	35.0	38.8	39.0	37.0
Wyoming	......	......	......	......	......	......	......	......	32.5	21.4
Colorado	28.3	27.8	31.3	20.0	28.0	30.5	28.0	24.8	28.7	26.3
New Mexico	21.6	27.0	28.0	19.0	32.5	33.8	32.0	29.0	31.7	16.1
Arizona	......	......	......	......	......	......	......	......	28.7	25.2
Utah	37.6	33.0	30.0	27.1	31.0	37.0	33.0	36.5	35.0	32.1
Nevada	......	......	......	......	......	......	......	......	33.0	34.3
Idaho	30.0	32.6	24.5	15.3	35.0	35.0	35.0	32.8	40.2	46.3
Washington	40.1	33.7	37.3	26.0	45.0	39.8	35.0	33.4	43.5	43.7
Oregon	26.1	38.6	22.1	21.8	32.5	29.1	28.0	28.9	30.6	31.9
California	22.5	15.2	20.3	21.6	23.0	10.5	26.0	16.7	26.0	26.0
Oklahoma	......	......	......	......	......	......	......	......	22.0	36.0
General average	21.7	19.4	26.4	23.6	24.5	21.6	25.5	20.4	25.6	29.0

Average yield of barley in certain countries, in bushels per acre, 1894–1901.

Year.	United States.	Russia.	Germany.	Austria.	Hungary.	France.	United Kingdom.
	(a)	(b)	(b)	(b)	(b)	(a)	(a)
1894	19.4	15.3	33.0	22.3	22.7	22.0	35.9
1895	26.4	13.7	31.2	20.9	21.4	21.9	33.1
1896	23.6	12.8	30.7	19.3	24.0	21.8	35.2
1897	24.5	11.8	29.0	17.6	17.6	19.4	33.9
1898	21.6	14.9	32.2	22.0	23.6	23.3	37.4
1899	25.5	11.1	33.8	24.9	24.0	22.7	35.7
1900	20.4	11.4	33.4	20.2	20.9	21.8	32.7
1901	29.0	11.2	31.0	22.5	20.0	20.1	32.7
Average	20.2	12.8	31.8	21.2	21.8	21.6	34.6

a Winchester bushels. b Bushels of 48 pounds.

Average value per acre of barley in the United States, based upon farm value December 1, 1893–1902, by States.

States and Territories.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.
Maine	$17.49	$17.23	$16.85	$13.16	$13.75	$15.12	$17.11	$16.99	$18.43	$19.39
New Hampshire	17.71	15.37	14.34	15.53	13.50	13.63	16.25	15.21	17.20	15.90
Vermont	16.50	16.74	15.60	13.53	13.11	14.10	16.12	15.13	19.51	18.12
Massachusetts	22.77	13.67	14.63	17.40	22.77	16.17	20.40	17.80	......	......
Rhode Island	21.92	21.60	17.63	17.40	15.12	17.08	20.30	21.56	......	......
New York	12.18	9.80	18.55	9.05	10.50	12.10	12.00	11.22	7.84	15.68
Pennsylvania	9.50	7.97	8.28	6.83	9.55	8.54	10.29	9.50	10.15	11.84
Maryland	......	......	......	......	......	......	......	......	9.36	13.23
Virginia	......	......	......	......	......	......	......	......	11.70	9.88
Texas	8.99	8.41	11.66	6.00	10.75	10.00	11.88	17.71	11.88	15.34
Tennessee	8.31	7.73	11.55	6.30	10.62	10.08	7.04	9.11	11.76	9.76
Kentucky	8.67	13.49	12.65	5.92	8.00	6.40	9.03	15.73	13.77	14.50
Ohio	10.67	13.68	11.56	7.68	11.69	12.63	12.60	11.61	12.70	15.83
Michigan	8.04	10.30	7.78	9.37	8.60	11.09	11.52	11.23	12.31	14.87
Indiana	8.95	9.32	6.00	6.70	8.36	10.30	11.25	11.56	12.95	12.88
Illinois	9.28	11.28	9.00	7.35	9.50	10.65	13.63	12.03	12.99	12.58
Wisconsin	10.32	12.87	9.96	7.40	8.96	11.64	12.00	11.22	13.87	15.55
Minnesota	7.96	9.63	8.64	5.44	6.12	9.37	7.75	8.51	11.61	10.58
Iowa	7.46	6.51	6.44	5.52	5.76	8.84	8.06	9.77	11.09	9.47
Missouri	8.00	7.14	7.34	4.38	7.60	7.20	7.56	9.36	9.08	13.75
Kansas	3.81	4.31	3.31	1.01	4.38	7.56	4.59	7.10	7.15	6.08
Nebraska	3.72	2.45	6.82	3.78	5.28	6.78	7.80	5.81	6.56	10.26
South Dakota	5.08	4.72	3.71	5.42	4.40	6.21	6.67	4.43	9.41	11.10
North Dakota	4.71	7.24	6.08	3.38	6.07	7.66	7.92	2.87	11.28	11.38
Montana	15.05	9.00	14.75	13.75	19.00	20.52	17.85	18.62	22.23	18.87
Wyoming	......	......	......	......	......	......	......	......	21.12	18.30
Colorado	14.15	16.04	18.78	9.20	14.28	14.03	15.40	12.40	18.08	15.78
New Mexico	12.53	18.90	19.04	12.35	17.88	18.59	19.52	17.98	20.61	11.43
Arizona	......	......	......	......	......	......	......	......	19.52	22.93
Utah	16.92	15.18	11.70	11.38	13.95	17.39	17.16	20.07	18.55	18.94
Nevada	......	......	......	......	......	......	......	......	23.10	27.44
Idaho	15.90	15.32	10.29	3.37	14.70	16.80	16.10	16.40	21.31	24.54
Washington	15.64	10.78	14.17	10.40	19.35	17.91	15.40	13.03	17.83	20.10
Oregon	10.44	12.74	8.84	9.81	14.63	14.26	14.00	12.14	14.99	16.59
California	9.45	6.84	8.12	10.37	12.42	6.82	13.00	7.18	10.66	16.38
Oklahoma	......	......	......	......	......	......	......	......	10.78	15.12
General average	8.92	8.56	8.88	7.62	9.25	8.93	10.28	8.32	11.57	13.28

Average farm price per bushel of barley in the United States December 1, 1893–1902, by States.

States and Territories.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
Maine	67	66	52	43	55	56	59	62	67	68
New Hampshire	70	63	56	53	60	58	65	67	80	75
Vermont	60	60	47	41	46	47	52	52	66	61
Massachusetts	90	63	65	58	66	66	68	69	......	......
Rhode Island	87	72	75	60	54	61	70	77	......	......
New York	60	56	81	39	42	48	50	51	56	55
Pennsylvania	50	48	41	40	39	44	49	50	59	54
Maryland	......	......	......	......	......	......	......	......	52	49
Virginia	......	......	......	......	......	......	......	......	47	54
Texas	62	55	54	50	43	50	66	72	88	72
Tennessee	55	56	50	45	59	56	64	62	70	61

Average farm price per bushel of barley in the United States, etc.—Continued.

States and Territories.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
Kentucky	51	47	38	40	40	40	43	55	71	56
Ohio	47	48	41	38	41	44	45	43	51	49
Michigan	49	50	43	42	40	44	48	47	54	52
Indiana	45	45	40	33	44	44	45	47	51	46
Illinois	40	48	45	31	38	39	47	47	53	44
Wisconsin	43	45	34	27	32	40	40	44	51	46
Minnesota	36	41	24	20	24	33	31	38	45	37
Iowa	33	42	23	21	24	34	31	37	47	36
Missouri	40	51	48	25	40	36	42	45	55	55
Kansas	47	49	23	22	25	27	27	33	45	38
Nebraska	31	43	24	19	24	25	30	33	41	33
South Dakota	33	35	19	19	22	27	29	31	42	38
North Dakota	31	36	20	21	27	29	33	35	40	36
Montana	50	40	59	55	50	57	51	48	52	51
Wyoming	......	......	......	......	......	......	......	......	65	75
Colorado	50	58	60	46	51	46	55	50	63	60
New Mexico	58	70	68	65	55	55	61	62	65	71
Arizona	......	......	......	......	......	......	......	......	68	91
Utah	45	46	39	42	45	47	52	55	53	59
Nevada	......	......	......	......	......	......	......	......	70	80
Idaho	53	47	42	22	42	48	46	50	53	53
Washington	39	32	38	40	43	45	44	39	41	46
Oregon	40	33	40	45	45	49	50	42	49	52
California	42	45	40	48	54	65	50	43	41	63
Oklahoma	......	......	......	......	......	......	......	......	49	42
General average	41.1	44.2	33.7	32.3	37.7	41.3	40.3	40.8	45.2	45.9

Transportation rates, average for barley in sacks, in cents per 100 pounds, St. Louis to New Orleans by river.

1882	20.00	1889	17.93	1896	14.55
1883	17.75	1890	15.66	1897	15.00
1884	14.00	1891	16.28	1898	10.00
1885	15.00	1892	16.87	1899	10.00
1886	16.00	1893	17.54	1900	10.00
1887	18.25	1894	17.14	1901	10.00
1888	15.00	1895	12.50	1902	10.00

Wholesale prices of barley per bushel in leading cities of the United States, 1898–1902.

Date.	New York.		Cincinnati.		Chicago.		San Francisco.	
	Western.		Extra No. 3 spring.		No. 3.		No. 1, brewing (per cwt.).	
	Low.	High.	Low.	High.	Low.	High.	Low.	High.
1898.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*		
January	50	52	32	36	26½	42	$0.92½	$0.97½
February	52	53	32	42	27½	42	.97½	1.07¼
March	52	54	36	42	32	43	1.07½	1.20
April	54	55	36	42	34	52	1.22½	1.42½
May	55	61	36	53	36	53	1.25	1.35
June	48	60	....	....	30	46	1.15	1.22½
July	46	48	....	....	30	38	1.17½	1.22½
August	46	48	....	....	30	47½	1.15	1.20
September	46	48	42	42	32½	45	1.15	1.22½
October	48	50	42	45	32	49	1.20	1.22½
November	52	56	47	54	36	50	1.20	1.27½
December	57	60	47	54	40	50½	1.22½	1.30
1899.								
January	57	62	50	56	41	54	1.40	1.47½
February	60	62	50	56	41	53	1.40	1.42½
March	53	60	50	53	38	51	1.35	1.42½
April	54	55	50	53	39	48	1.20	1.37½
May	50	54	50	53	36	42	1.17½	1.25
June	46	52	....	....	35½	42	1.02½	1.22½
July	48	50	....	....	34	42	1.05	1.15
August	46	50	....	....	34	43	.97½	1.05
September	50	52	44	50	36	47	.95	1.01¼
October	50	54	50	50	37	46	1.00	1.03¾
November	46	50	48	50	34	45	.96¼	1.01¼
December	49	52	45	50	35	45	.85	.97½

Wholesale prices of barley per bushel in leading cities of the United States—Continued.

Date.	New York.		Cincinnati.		Chicago.		San Francisco.	
	Western.		Extra No. 3 spring.		No. 3.		No. 1, brewing (per cwt.).	
	Low.	High.	Low.	High.	Low.	High.	Low.	High.
1900.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*		
January	49	50	44¾	49	34	48	$0.72½	$0.75
February	50	51	47	49	34	46	.72½	.75
March	52	50	47	49	36	44	.72½	.73¾
April	52	52½	47	49	36	45	.72½	.72½
May	52	52	47	49	36	44	.67½	.72½
June	51	55	....	....	36	48	.67½	.70
July	54	54	....	....	36	48	.70	.71¼
August	52	57	....	....	33	50	.72½	.72½
September	54	58	46	55	38	57	.72½	.72½
October	60	62	56	64	36	59	.71¼	.72½
November	62	65	56	66	36	62	.72½	.75
December	64	66	58	66	37	61	.72½	.75
1901.								
January	65	68	68	75	36	63	.75	.80
February	65	70	70	75	37	61	.73¾	.81¼
March	59	65	66	75	37	59	.75	.82½
April	61	63	64	72	38	58	.78¾	.85
May	63	63	62	70	37	57	.77½	.81¼
June	Nominal.		62	65	40	54	.75	.80
July	57	60	....	....	40	65	.77½	.82½
August	64	67	....	....	48	65	.80	.83¾
September	65	67	67	69	50	62	.80	.82½
October	60	68	64	69	51	60	.77½	.82½
November	62	69	64	70	51	63	.76¾	.82½
December	70	72	69	71	56	63	.78¾	.85
1902.								
January	72	75	67	70	57	65½	.80	.95
February	73	73	67	69	58	64	.90	1.02½
March	73	74	67	70	58	67	.92½	1.02½
April	73	74	68	74	61	70	.93¾	1.02½
May	74	75	67	69	64	72	.95	1.07½
June	Nominal.		67	69	64	71	.92½	1.01¼
July	None.		....	....	48	73	.92½	1.00
August	71	72	....	....	41	65	.93¾	1.01¼
September	65	71	55	65	38	63	.96¼	1.15
October	64	66	55	65	35	60	1.12½	1.25
November	66	66	55	65	35	58	1.18¾	1.30
December	68	68	55	65	36	70	1.22½	1.32½

RYE.

The 1902 rye crop of the world and that of the United States also exceeded in amount the yields of former years. The world's crop was 1,678,714,000 bushels and the production of the United States 33,630,592 bushels. An average yield per acre of 17 bushels for the United States exceeded the yield for any previous year.

Following the changes and fluctuations of the corn and wheat markets, the wholesale cash prices of rye ruled high. Prices at Chicago covered a range of 19½ cents—from 48 cents in August to 67½ cents in January.

Rye crop of the countries named, 1898–1902.

Country.	1898.	1899.	1900.	1901.	1902.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
United States	25,658,000	23,962,000	23,996,000	30,345,000	33,631,000
Ontario	2,757,000	2,357,000	2,432,000	2,625,000	3,620,000
Manitoba	66,000	66,000	27,000	64,000	51,000
Rest of Canada	420,000	400,000	375,000	800,000	800,000
Total Canada	3,243,000	2,823,000	2,834,000	3,489,000	4,471,000
Total North America	28,901,000	26,785,000	26,830,000	33,834,000	38,102,000
Great Britain	1,782,000	....	....	....	....
Ireland	316,000	....	....	....	....
Total United Kingdom	2,098,000	2,000,000	2,000,000	2,000,000	2,000,000

Rye crop of the countries named, 1898–1902—Continued.

Country.	1898.	1899.	1900.	1901.	1902.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
Sweden	21,469,000	21,436,000	26,008,000	22,646,000	23,124,000
Denmark	16,132,000	18,359,000	19,958,000	16,605,000	16,500,000
Netherlands	13,664,000	12,967,000	13,644,000	13,600,000	12,800,000
Belgium	18,991,000	16,544,000	19,854,000	25,045,000	21,195,000
France	66,755,000	66,904,000	59,277,000	58,198,000	53,582,000
Spain	19,324,000	20,519,000	19,000,000	23,000,000	23,000,000
Italy	4,000,000	2,700,000	4,000,000	4,000,000	3,200,000
Germany	355,581,000	341,551,000	336,624,000	321,350,000	373,768,000
Austria	79,687,000	85,268,000	54,792,000	75,514,000	82,482,000
Hungary	42,797,000	47,204,000	39,900,000	44,377,000	53,541,000
Croatia-Slavonia	3,497,000	2,668,000	2,286,000	2,774,000	4,453,000
Total Austria-Hungary	125,981,000	135,140,000	96,978,000	122,665,000	140,476,000
Roumania	7,629,000	1,988,000	5,990,000	9,573,000	6,958,000
Bulgaria	5,437,000	4,655,000	7,000,000	7,000,000	8,000,000
Russia proper	636,467,000	805,230,000	828,816,000	680,205,000	810,529,000
Poland	72,029,000	67,580,000	67,621,000	50,781,000	75,257,000
North Caucasus	5,572,000	7,638,000	7,500,000	7,937,000	8,654,000
Total Russia in Europe	714,068,000	880,448,000	903,937,000	738,923,000	894,440,000
Total Europe	1,371,129,000	1,525,211,000	1,514,270,000	1,364,605,000	1,579,043,000
Siberia	22,627,000	30,523,000	15,853,000	15,620,000	23,080,000
Central Asia	804,000	660,000	341,000	382,000	1,489,000
Total Russia in Asia	23,431,000	31,183,000	16,194,000	16,002,000	24,569,000
Japan	37,710,000	33,818,000	38,369,000	35,000,000	37,000,000
Grand total	1,461,171,000	1,616,997,000	1,595,653,000	1,449,441,000	1,678,714,000

Visible supply of rye in the United States first of each month for ten years.[a]

Month.	1893–1894.	1894–1895.	1895–1896.	1896–1897.	1897–1898.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels*	*Bushels.*
July	480,000	289,000	158,000	1,575,000	2,464,000
August	408,000	263,000	215,000	1,630,000	1,946,000
September	434,000	372,000	511,000	2,328,000	2,499,000
October	582,000	411,000	700,000	2,040,000	3,064,000
November	658,000	556,000	1,250,000	2,596,000	3,832,000
December	723,000	508,000	1,702,000	2,695,000	3,932,000
January	717,000	583,000	1,739,000	3,276,000	4,436,000
February	720,000	508,000	1,763,000	4,266,000	4,291,000
March	638,000	423,000	1,710,000	4,104,000	4,099,000
April	532,000	366,000	1,631,000	4,128,000	3,682,000
May	489,000	182,000	1,481,000	3,607,000	3,039,000
June	302,000	177,000	1,467,000	2,798,000	1,526,000

Month.	1898–1899.	1899–1900.	1900–1901.	1901–1902.	1902–1903.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
July	988,000	904,000	806,000	747,000	442,000
August	365,000	638,000	725,000	753,000	328,000
September	721,000	647,000	1,056,000	1,864,000	903,000
October	894,000	962,000	1,216,000	2,440,000	1,362,000
November	1,260,000	1,906,000	1,513,000	2,863,000	1,828,000
December	1,212,000	1,892,000	1,754,000	3,463,000	2,159,000
January	1,573,000	1,806,000	1,651,000	3,257,000	2,454,000
February	1,576,000	1,734,000	1,530,000	3,270,000	2,354,000
March	1,724,000	1,951,000	1,532,000	2,972,000	2,273,000
April	1,658,000	1,566,000	1,333,000	2,639,000	1,688,000
May	1,335,000	1,441,000	1,112,000	1,910,000	1,879,000
June	975,000	1,206,000	938,000	950,000	....

[a] These figures represent stocks available at 62 of the principal points of accumulation east of the Rocky Mountains, stocks in Manitoba elevators, and stocks afloat on lakes and canals, as reported by Bradstreet's.

Condition of the rye crop of the United States, monthly, 18[illegible]–19[illegible].

Year.	Apr.	May.	June.	July.	Aug.	When harvested.	Year.	Apr.	May.	June.	July.	Aug.	When harvested.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	......	[illegible]	[illegible]	90.7	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	88.7	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	87.7	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	88.0	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	94.5	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	85.2	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	86.5	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	93.6	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Acreage, production, value, prices, and exports of rye of the United States, 18[illegible]–1902.

Year.	Acreage.	Average yield per acre.	Production.	Average farm price per bushel Dec. 1.	Farm value Dec. 1.	Chicago cash price per bushel, No. 2. [illegible] Low.	[illegible] High.	[illegible] Low.	[illegible] High.	Domestic exports, including rye flour, fiscal years beginning July 1.
	Acres.	Bush.	Bushels.	Cents.	Dollars.	Cents.	Cents.	Cents.	Cents.	Bushels.
[illegible]	1,548,[illegible]	13.5	[illegible]	[illegible]	17,149,716	......	......	142	150	[illegible]
[illegible]	1,689,[illegible]	13.7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	173	185	[illegible]
[illegible]	1,651,[illegible]	13.6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	100	115½	92,[illegible]
[illegible]	1,657,[illegible]	13.6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	75	83½	[illegible]
[illegible]	1,176,[illegible]	13.2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	81	91	87,[illegible]
[illegible]	1,069,[illegible]	14.4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	75	93	[illegible]
[illegible]	1,048,[illegible]	14.2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	68½	70	611,[illegible]
[illegible]	1,150,[illegible]	13.2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	91	102	[illegible]
[illegible]	1,116,[illegible]	13.4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	106	107½	267,[illegible]
[illegible]	1,359,[illegible]	13.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	61½	70½	589,[illegible]
[illegible]	1,468,[illegible]	13.9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	70	92½	[illegible]
[illegible]	1,412,[illegible]	15.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	54	60	1,249,[illegible]
[illegible]	1,622,[illegible]	15.9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	47	52	[illegible]
[illegible]	1,625,[illegible]	14.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	73½	85	[illegible]
[illegible]	1,767,[illegible]	13.9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	115	118	1,955,[illegible]
[illegible]	1,789,[illegible]	11.6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	77	83	[illegible]
[illegible]	2,227,[illegible]	13.4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	62	67	[illegible]
[illegible]	[illegible]	12.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	60½	62½	[illegible]
[illegible]	2,343,[illegible]	12.2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	68	73	[illegible]
[illegible]	2,129,[illegible]	10.2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	55	61	216,[illegible]
1886	[illegible]	11.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	54½	56½	[illegible]
1887	2,[illegible]	10.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	63	65	[illegible]
1888	2,364,805	12.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	39	42½	309,[illegible]
1889	2,171,493	13.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	49½	54	[illegible]
1890	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	83	92	358,[illegible]
1891	2,176,466	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	70½	79	[illegible]
1892	2,163,657	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50½	62	[illegible]
[illegible]	2,038,485	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	44½	48	249,[illegible]
[illegible]	1,944,780	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	62½	67	[illegible]
[illegible]	1,890,345	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	33	36½	[illegible]
[illegible]	1,831,201	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	32½	35½	[illegible]
[illegible]	1,703,561	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	48	75	[illegible]
[illegible]	1,643,207	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50½	62	[illegible]
[illegible]	1,659,308	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	53	56½	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	51½	54	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	54½	58	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	......	......	......

Acreage, production, and value of rye in the United States in 1902, by States.

[illegible]	Acreage.	Average yield per acre.	Production.	Average farm price, Dec. 1.	Average value per acre, Dec. 1.	Farm value, Dec. 1.
	[illegible]	[illegible]	Bushels.	Cents.	Dollars.	Dollars.
[illegible]	[illegible]	[illegible]	[illegible],897	77	[illegible]	[illegible],284
[illegible]	[illegible]	[illegible]	[illegible],092	80	[illegible]	[illegible],662
[illegible]	[illegible]	[illegible]	[illegible],780	75	[illegible]	139,[illegible]
[illegible]	[illegible]	[illegible]	[illegible],262	58	[illegible]	1,[illegible]
[illegible]	[illegible]	[illegible]	[illegible],286	61	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible],160	53	[illegible]	3,[illegible]
[illegible]	[illegible]	[illegible]	[illegible],432	62	[illegible]	8,94[illegible]
[illegible]	[illegible]	[illegible]	[illegible],174	58	[illegible]	[illegible],041
[illegible]	[illegible]	[illegible]	[illegible],011	66	[illegible]	165,65[illegible]
[illegible]	[illegible]	[illegible]	[illegible],845	85	[illegible]	158,81[illegible]
[illegible]	[illegible]	[illegible]	[illegible],125	113	[illegible]	36,8[illegible]
[illegible]	[illegible]	[illegible]	[illegible],077	110	[illegible]	96,44[illegible]

Acreage, production, and value of rye in the United States in 1902, by States—Continued.

States and Territories.	Acreage.	Average yield per acre.	Production.	Average farm price, Dec. 1.	Average value per acre. Dec. 1.	Farm value, Dec. 1.
	Acres.	*Bushels.*	*Bushels.*	*Cents.*	*Dollars.*	*Dollars.*
Alabama	1,638	10.0	16,380	105	10.50	17,199
Texas	3,596	9.9	35,600	76	7.52	27,056
Arkansas	2,612	12.3	32,128	73	8.98	23,453
Tennessee	13,339	11.0	146,729	73	8.03	107,112
West Virginia	10,830	8.1	87,723	68	5.51	59,652
Kentucky	13,694	13.4	183,500	62	8.31	113,770
Ohio	15,587	17.5	272,772	53	9.27	144,569
Michigan	155,288	17.9	2,779,655	49	8.77	1,362,031
Indiana	39,628	14.5	574,606	46	6.67	264,319
Illinois	78,369	19.1	1,496,848	50	9.55	748,424
Wisconsin	328,552	18.9	6,209,633	50	9.45	3,104,816
Minnesota	97,003	22.3	2,163,167	43	9.59	930,162
Iowa	71,261	17.4	1,239,941	42	7.31	520,775
Missouri	24,249	18.2	441,332	48	8.74	211,839
Kansas	88,024	12.0	1,056,288	45	5.40	475,330
Nebraska	160,139	20.3	3,250,822	36	7.31	1,170,296
South Dakota	36,726	18.8	690,449	41	7.71	283,084
North Dakota	23,814	20.2	481,043	43	8.69	206,848
Montana	1,871	25.0	46,775	64	16.00	29,936
Wyoming	523	18.0	9,414	50	9.00	4,707
Colorado	2,872	15.9	45,665	56	8.90	25,572
Utah	3,493	12.4	43,313	61	7.56	26,421
Idaho	1,220	20.2	24,644	60	12.12	14,786
Washington	2,910	17.8	51,798	64	11.39	33,151
Oregon	11,026	13.4	147,748	73	9.78	107,856
California	67,409	12.0	808,908	75	9.00	606,681
Oklahoma	3,570	16.0	57,120	47	7.52	26,846
United States	1,978,548	17.0	33,630,592	50.8	8.63	17,080,793

Average yield per acre of rye in the United States, 1893–1902, by States.

States and Territories.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.
	Bush.	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*
Maine	12.0	16.5	19.2	18.0	13.5	18.0	15.0	17.2	......	......
New Hampshire	15.1	15.4	16.0	19.6	18.0	17.5	15.0	17.1	......	......
Vermont	14.0	13.1	16.0	18.6	16.0	19.1	17.0	16.6	18.3	16.9
Massachusetts	16.2	19.2	19.9	22.0	19.5	16.7	16.0	16.9	15.9	15.2
Connecticut	15.9	12.9	16.9	15.4	19.0	18.0	18.0	17.0	18.0	17.4
New York	14.9	15.4	18.1	14.3	18.5	17.5	16.0	15.1	14.9	17.5
New Jersey	13.4	14.8	13.6	13.8	17.0	15.5	15.0	15.9	15.0	16.4
Pennsylvania	14.7	13.9	15.1	16.0	19.0	16.1	15.0	15.3	15.9	16.0
Delaware	......	......	......	......	......	......	......	......	15.3	13.5
Maryland	13.1	13.5	12.9	9.2	17.0	14.5	14.0	16.5	14.4	14.0
Virginia	9.3	8.8	11.0	10.0	11.0	11.2	9.0	10.5	11.1	9.6
North Carolina	7.7	9.0	7.7	7.5	8.8	9.1	7.0	8.9	8.5	8.2
South Carolina	5.4	4.7	9.3	4.8	6.6	8.5	5.0	7.5	7.7	7.6
Georgia	6.4	6.5	7.2	7.1	7.4	8.0	6.0	7.0	7.6	6.3
Alabama	9.8	13.3	10.2	8.0	9.6	11.1	8.0	7.8	8.0	10.0
Texas	9.3	11.3	5.5	7.0	12.0	12.0	10.0	16.5	11.1	9.9
Arkansas	7.5	9.0	10.0	10.0	11.0	11.4	11.0	11.5	8.7	12.3
Tennessee	9.5	7.6	7.2	9.0	10.0	10.5	9.0	11.0	11.3	11.0
West Virginia	8.2	8.0	16.1	10.6	11.5	11.2	10.0	10.5	12.0	8.1
Kentucky	13.2	12.2	13.2	11.0	13.0	13.0	10.0	13.1	14.0	13.4
Ohio	15.2	18.3	14.8	9.6	18.0	17.4	16.0	16.6	16.9	17.5
Michigan	12.8	13.2	13.6	9.2	15.0	15.3	14.0	14.6	14.0	17.9
Indiana	14.4	19.3	12.2	10.6	13.0	15.5	13.0	15.1	14.5	14.5
Illinois	13.9	18.6	15.2	15.3	15.5	14.8	15.0	17.2	17.0	19.1
Wisconsin	14.5	16.0	16.1	14.5	16.0	15.3	15.0	15.8	15.9	18.9
Minnesota	15.3	17.5	21.1	15.6	17.2	20.5	18.0	19.5	19.3	22.3
Iowa	14.6	16.9	20.6	17.5	16.0	19.0	18.0	18.0	18.4	17.4
Missouri	12.8	15.4	12.2	12.2	12.0	13.1	13.0	14.0	14.2	18.2
Kansas	7.0	5.8	5.9	7.0	14.0	15.6	11.0	15.2	14.3	12.0
Nebraska	10.1	6.1	9.3	16.9	17.0	18.8	16.0	14.2	15.0	20.3
South Dakota	10.6	4.5	8.4	11.6	16.5	16.6	15.0	10.6	14.4	18.8
North Dakota	12.3	15.0	21.3	12.0	14.5	15.0	15.0	5.2	13.8	20.2
Montana	......	......	......	......	......	......	......	......	26.7	25.0
Wyoming	......	......	......	......	......	......	......	......	24.0	18.0
Colorado	21.0	15.6	14.5	23.5	15.0	18.0	14.0	16.8	16.1	15.9
Utah	11.9	19.0	19.8	20.0	12.0	19.5	17.0	17.5	14.2	12.4
Idaho	......	......	......	......	......	......	......	......	15.0	20.2
Washington	15.1	14.4	26.7	15.0	19.5	18.0	16.0	16.3	17.5	17.8
Oregon	10.5	14.1	11.2	12.7	15.0	14.4	11.0	16.1	15.7	13.4
California	17.5	13.2	11.6	14.3	12.2	9.0	15.0	13.0	12.8	12.0
Oklahoma	......	......	......	......	......	......	......	......	14.8	16.0
General average	13.0	13.7	14.4	13.3	16.1	15.6	14.4	15.1	15.3	17.0

Average yield of rye in certain countries, in bushels per acre, 1894–1901.

Year.	United States.	Russia.	Germany.	Austria.	Hungary.	France.	Ireland.
	(a)	(b)	(b)	(b)	(b)	(a)	(b)
1894	13.7	12.7	22.0	17.2	19.5	19.5	25.4
1895	14.4	11.6	20.9	14.5	16.7	18.8	26.8
1896	13.3	10.9	22.7	16.3	18.2	18.7	25.4
1897	16.1	9.3	21.8	13.9	13.5	13.4	21.6
1898	15.6	10.5	24.2	17.7	16.9	18.3	25.8
1899	14.4	12.8	23.6	18.7	17.7	18.2	25.7
1900	15.1	12.5	22.9	13.0	15.1	16.9	26.4
1901	17.0	14.0	22.4	16.9	15.8	16.7	27.4
Average	15.0	11.6	22.6	15.5	16.7	17.6	25.6

a Winchester bushels. b Bushels of 56 pounds.

Average value per acre of rye in the United States, based upon farm value December 1, 1893–1902, by States.

States and Territories.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.
Maine	$12.96	$13.37	$16.32	$12.06	$11.07	$15.12	$12.60	$14.10	......	......
New Hampshire	11.78	11.40	12.16	14.11	15.12	13.12	12.15	14.02	......	......
Vermont	10.22	9.56	9.12	12.09	9.60	11.08	10.54	10.13	$14.64	$13.01
Massachusetts	12.15	14.02	13.33	15.40	11.90	10.52	12.64	12.68	12.56	12.16
Connecticut	10.49	8.39	10.65	8.78	11.21	10.80	11.52	11.05	12.96	13.05
New York	9.39	8.32	8.69	6.29	8.88	8.75	8.96	8.46	9.24	10.15
New Jersey	9.38	8.14	6.94	6.49	8.50	7.75	8.25	8.74	8.85	10.00
Pennsylvania	8.38	7.78	7.55	7.52	8.17	7.57	7.65	8.11	9.54	8.48
Delaware	......	......	......	......	......	......	......	......	8.87	8.37
Maryland	6.68	6.35	6.32	4.42	7.82	7.83	7.98	8.58	8.06	8.12
Virginia	5.21	4.75	5.72	4.80	5.50	5.15	4.77	6.09	6.77	6.34
North Carolina	5.39	6.30	4.93	5.32	5.28	5.82	5.25	6.76	6.63	6.97
South Carolina	5.94	4.51	10.70	4.18	5.68	8.67	5.45	7.87	8.55	8.59
Georgia	6.91	6.31	6.12	7.17	6.81	7.84	6.72	7.21	8.06	6.93
Alabama	11.27	12.64	8.57	7.04	11.33	11.65	8.32	8.03	8.32	10.50
Texas	6.32	8.48	4.13	4.69	8.64	8.52	8.20	11.05	10.32	7.52
Arkansas	4.35	6.84	6.20	7.00	9.46	7.41	8.14	8.28	7.74	8.98
Tennessee	5.60	4.48	4.46	5.40	5.80	5.56	6.03	7.48	8.36	8.03
West Virginia	5.33	4.56	9.82	5.94	5.87	5.82	6.20	6.72	7.80	5.51
Kentucky	7.66	7.20	7.39	5.94	6.89	7.15	7.00	8.25	9.38	8.31
Ohio	7.14	8.23	6.66	3.74	7.92	7.83	8.80	9.13	9.30	9.27
Michigan	5.63	6.07	5.44	2.94	6.30	6.58	7.28	7.01	7.28	8.77
Indiana	6.48	8.11	5.12	3.82	5.46	6.67	6.24	7.55	7.68	6.67
Illinois	5.70	8.00	6.08	5.20	6.82	6.51	7.05	8.08	9.69	9.55
Wisconsin	6.24	6.88	5.64	4.82	6.56	6.58	7.20	7.74	8.27	9.45
Minnesota	6.27	7.53	5.91	4.68	6.36	7.79	7.56	8.19	9.46	9.59
Iowa	5.99	7.77	6.39	5.08	5.76	7.60	7.20	7.38	9.20	7.31
Missouri	5.76	7.24	4.76	5.73	5.28	6.16	6.50	7.14	9.51	8.74
Kansas	2.66	2.67	2.24	2.45	5.60	5.77	4.62	6.54	7.87	5.40
Nebraska	3.54	2.93	2.79	3.72	5.44	6.39	6.08	5.68	6.90	7.31
South Dakota	3.92	2.07	2.10	3.13	5.78	5.64	5.55	4.13	6.19	7.71
North Dakota	3.94	5.55	5.75	2.64	5.22	5.40	5.55	2.13	5.93	8.69
Montana	......	......	......	......	......	......	......	......	16.02	16.00
Wyoming	......	......	......	......	......	......	......	......	19.20	9.00
Colorado	10.50	10.30	6.96	14.57	7.80	9.00	6.72	9.07	9.98	8.90
Utah	5.59	10.83	6.93	8.00	7.20	8.97	8.16	9.10	9.23	7.56
Idaho	......	......	......	......	......	......	......	......	10.05	12.12
Washington	10.42	8.06	20.03	7.50	12.09	10.44	9.60	9.45	10.85	11.39
Oregon	7.66	8.04	6.05	7.62	8.85	10.37	7.70	9.82	10.36	9.78
California	10.50	7.92	6.73	8.70	7.93	6.30	11.70	7.54	7.30	9.00
Oklahoma	......	......	......	......	......	......	......	......	10.36	7.52
General average	6.68	6.89	6.33	5.44	7.18	7.23	7.36	7.73	8.51	8.63

Average farm price of rye per bushel in the United States December 1, 1893–1902, by States.

States and Territories.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
Maine	108	81	85	67	82	84	84	82	......	......
New Hampshire	78	74	76	72	84	75	81	82	......	......
Vermont	73	73	67	65	60	58	62	61	80	70
Massachusetts	75	73	67	70	61	63	79	75	79	80
Connecticut	66	65	63	57	59	60	64	65	72	75
New York	63	54	48	44	48	50	56	56	62	58
New Jersey	70	55	51	47	50	50	55	55	59	61
Pennsylvania	57	56	50	47	43	47	51	53	60	53
Delaware	......	......	......	......	......	......	......	......	58	62
Maryland	51	47	49	48	46	54	57	52	56	58
Virginia	56	54	52	48	50	46	53	58	61	66
North Carolina	70	70	64	71	60	64	75	76	78	85
South Carolina	110	96	115	87	86	102	109	105	111	113
Georgia	108	97	85	101	92	98	112	103	106	110
Alabama	115	95	84	88	118	105	104	103	104	105
Texas	68	75	75	67	72	71	82	67	93	76
Arkansas	58	76	72	70	86	65	74	72	89	73
Tennessee	59	59	62	60	58	53	67	68	74	73
West Virginia	65	57	61	56	51	52	62	64	65	68
Kentucky	58	59	56	54	53	55	70	63	67	62
Ohio	47	45	45	39	44	45	55	55	55	53
Michigan	44	46	40	32	42	43	52	48	52	49
Indiana	45	42	42	36	42	43	48	50	53	46
Illinois	41	43	40	34	44	44	47	47	57	50
Wisconsin	43	43	35	33	41	43	48	49	52	50
Minnesota	41	43	28	30	37	38	42	42	49	43
Iowa	41	46	31	29	36	40	40	41	50	42
Missouri	45	47	39	47	44	47	50	51	67	48
Kansas	38	46	38	35	40	37	42	43	55	45
Nebraska	35	48	30	22	32	34	38	40	46	36
South Dakota	37	46	25	27	35	34	37	39	43	41
North Dakota	32	37	27	22	36	36	37	41	43	43
Montana	......	......	......	......	......	......	......	......	60	64
Wyoming	......	......	......	......	......	......	......	......	80	50
Colorado	50	65	48	62	52	50	48	54	62	56
Utah	47	57	35	40	60	46	48	52	65	61
Idaho	......	......	......	......	......	......	......	......	67	60
Washington	69	56	75	50	62	58	60	58	62	64
Oregon	73	57	54	60	59	72	70	61	66	73
California	60	60	58	60	65	70	78	58	57	75
Oklahoma	......	......	......	......	......	......	......	......	70	47
General average	51.3	50.1	44.0	40.9	44.7	46.3	51.0	51.2	55.7	50.8

Transportation rates, average for rye in sacks, in cents per 100 pounds, St. Louis to New Orleans by river.

1882	20.00	1889	17.93	1896	14.55
1883	17.75	1890	15.66	1897	15.00
1884	14.00	1891	16.28	1898	10.00
1885	15.00	1892	16.87	1899	10.00
1886	16.00	1893	17.54	1900	10.00
1887	18.25	1894	17.14	1901	10.00
1888	15.00	1895	12.50	1902	10.00

Wholesale prices of rye per bushel in leading cities of the United States, 1898–1902.

Date.	New York.		Cincinnati.		Chicago.		Duluth.	
	Prime State.		No. 2.		No. 2.			
	Low.	High.	Low.	High.	Low.	High.	Low.	High.
1898.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	54¼	57½	45½	53	44¼	48	45	47½
February	55½	59½	48	53	46¾	50½	46¼	50
March	58	60	52	54½	48¾	50½	48	49½
April	57½	69	52	66	50	62	49	62¼
May	60	74¾	52	80	48	75	48	72
June	49	58	40	51	41	49	41	51
July	50	55½	40	45	42¾	48½	41½	48½
August	49½	52½	45	50	41	46½	40½	45½
September	50	54½	45	48½	42½	49	42¾	47
October	53	60	48	57	44½	51½	44	50
November	58	60	56	59	49½	52¾	50	51
December	59¼	64	56	58½	52½	55½	50	54

Wholesale prices of rye per bushel in leading cities of the United States, 1898–1902—Cont'd.

Date.	New York. Prime State.		Cincinnati. No. 2.		Chicago. No. 2.		Duluth.	
	Low.	High.	Low.	High.	Low.	High.	Low.	High.
1899.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	63¾	67½	57	65	53½	58¾	53	58
February	64½	68	60	65	54	56¼	54½	56
March	63	67½	59	65	49¼	56½	48½	55¾
April	63	68½	60	65	52	59	50½	58
May	65	67	62	68	56½	62	56	58¼
June	64	66½	64	68	56	62	56	59¼
July	60	65½	57	67	51	60	50	[illegible]
August	59	61¾	56	60	51¼	56½	50½	53¼
September	61½	66	58	65	54	58	52¼	57½
October	61	63	61½	65½	54¼	58	53	57¼
November	56	62	59	64	49	53	48	52
December	58½	61½	60	65½	49	52	47	49½
1900.								
January	60	61¼	59	64	50	52	48½	50
February	60½	64½	61	65	51	55½	50	53
March	60½	63½	60	64	52½	55	51	53½
April	60½	63½	60	63½	53	55½	51½	52½
May	60¼	62½	61	63½	53	56¼	51¾	53¾
June	61½	68	61	67	52¾	60½	52½	60½
July	57	65	59	66	50	58	49	57½
August	54½	58	51½	60	48	51½	48	50½
September	56¾	60½	53	57	50¼	53½	50	53½
October	56	61	55	59	47¼	52¼	48	53
November	54	56	52	56	44½	48	46	48¾
December	54	56	52	55½	45¾	49¾	46¼	48½
1901.								
January	57	59	53	58½	47½	49¾	48	50
February	59½	61	56	59	48½	50¼	49¼	50½
March	60½	61	55	59	49½	51½	50¼	51¼
April	58½	60½	54	58½	48¾	53	49¾	53
May	59	61¾	57	62	51½	54	51	53
June	55	59½	55	61	46¾	53	46½	51½
July	51½	61	45	55½	47	57	46½	53½
August	59	61	52½	64	52	60	50	57¼
September	59	62	56½	60	52½	56	50	57¼
October	58	62½	56½	59½	53¼	56	50½	52½
November	63	68	57	65½	54½	61	52½	57¼
December	68½	72½	64½	73	59	65¾	57½	62½
1902.								
January	68	74	66	71½	56	67½	54	64
February	68	70	64	67	56	60½	53	57½
March	63	69	63	65	52½	58	52	54½
April	63	66	62	64	54½	57½	52	56
May	65	67	60	63½	54½	58	54	57
June	65	66¼	54	59	56¾	58	55¼	56½
July	65½	66½	55½	58	52¼	61½	51¼	58
August	57½	66	51	56	48	54	46	51
September	57	59¼	52½	55½	49	50½	47½	49
October	57	58⅜	52	53	48	50½	47	49
November	58	59	51	54	48½	51½	49	49¾
December	57½	59½	51	56	48	49¾	48	49¾

Monthly average prices of rye in Chicago.[a]

[Cents per bushel.]

Month.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.
January	$68\frac{3}{8}$	$82\frac{5}{8}$	54	$44\frac{3}{4}$	$49\frac{1}{4}$	$36\frac{7}{8}$	36	$46\frac{1}{2}$	$56\frac{1}{8}$	51	$48\frac{5}{8}$	$61\frac{3}{4}$
February	79	83	52	45	$51\frac{1}{2}$	$39\frac{1}{2}$	34	$48\frac{5}{8}$	$55\frac{1}{8}$	$53\frac{1}{4}$	$49\frac{3}{8}$	$58\frac{1}{4}$
March	$89\frac{7}{8}$	$80\frac{1}{2}$	$49\frac{1}{2}$	$47\frac{1}{4}$	$52\frac{1}{2}$	$37\frac{5}{8}$	$33\frac{1}{4}$	$49\frac{5}{8}$	$52\frac{11}{16}$	$53\frac{3}{4}$	$50\frac{1}{2}$	$56\frac{1}{4}$
April	$88\frac{1}{2}$	$73\frac{1}{4}$	$49\frac{1}{2}$	48	60	$36\frac{1}{4}$	$33\frac{3}{4}$	56	$55\frac{1}{2}$	$54\frac{1}{4}$	$50\frac{7}{8}$	56
May	$87\frac{1}{2}$	$74\frac{1}{2}$	57	$46\frac{1}{2}$	$64\frac{3}{4}$	$34\frac{3}{4}$	$34\frac{1}{8}$	$61\frac{1}{2}$	$59\frac{1}{4}$	$54\frac{5}{8}$	$52\frac{3}{4}$	$56\frac{1}{4}$
June	$79\frac{1}{2}$	77	$50\frac{1}{4}$	$47\frac{1}{2}$	$63\frac{3}{4}$	$31\frac{1}{4}$	$33\frac{3}{4}$	45	59	$57\frac{3}{8}$	$49\frac{7}{8}$	$57\frac{3}{8}$
July	$71\frac{1}{4}$	70	47	44	51	$30\frac{3}{8}$	$37\frac{3}{4}$	$45\frac{5}{8}$	$55\frac{1}{2}$	54	52	$56\frac{7}{8}$
August	$91\frac{3}{4}$	62	45	$45\frac{3}{4}$	42	30	$48\frac{1}{2}$	$43\frac{3}{4}$	54	$49\frac{3}{4}$	56	51
September	$86\frac{1}{2}$	$56\frac{3}{4}$	$43\frac{1}{2}$	$47\frac{1}{4}$	39	$33\frac{3}{8}$	$49\frac{1}{2}$	$45\frac{3}{4}$	56	$51\frac{7}{8}$	$54\frac{1}{4}$	$49\frac{3}{4}$
October	$87\frac{5}{8}$	52	45	47	39	$37\frac{1}{2}$	46	48	$56\frac{1}{8}$	$49\frac{3}{4}$	$54\frac{5}{8}$	$53\frac{3}{4}$
November	$91\frac{3}{4}$	50	$45\frac{1}{8}$	$47\frac{1}{4}$	$36\frac{1}{2}$	$39\frac{1}{2}$	$46\frac{1}{2}$	$51\frac{1}{8}$	51	$46\frac{1}{4}$	$57\frac{3}{4}$	50
December	89	$49\frac{1}{4}$	$46\frac{1}{2}$	$48\frac{7}{8}$	34	$39\frac{3}{4}$	$46\frac{3}{8}$	54	$50\frac{1}{2}$	$47\frac{5}{8}$	$62\frac{3}{8}$	$48\frac{7}{8}$
Yearly average	$84\frac{1}{4}$	$67\frac{9}{16}$	$48\frac{3}{4}$	$46\frac{1}{2}$	$48\frac{1}{2}$	$35\frac{1}{2}$	40	$49\frac{1}{2}$	$55\frac{1}{16}$	52	$53\frac{1}{4}$	$54\frac{5}{8}$

[a] This table exhibits average cash prices for the past twelve years. The monthly prices are the means between the lowest and highest prices for each month, and the yearly prices are the averages of the monthly averages

BUCKWHEAT.

Condition of buckwheat crop of United States, monthly, 1887–1902.

Year.	Aug.	Sept.	Oct.	Year.	Aug.	Sept.	Oct.	Year.	Aug.	Sept.	Oct.	Year.	Aug.	Sept.	Oct.
1887	93.3	89.1	76.6	1891	97.3	96.6	92.7	1895	85.2	87.5	84.8	1899	93.2	75.2	70.2
1888	92.5	93.7	79.1	1892	92.9	89.0	85.6	1896	96.0	93.2	86.0	1900	87.9	80.5	72.8
1889	95.2	92.1	90.0	1893	88.8	77.5	73.5	1897	94.9	95.1	90.8	1901	91.1	90.9	90.5
1890	90.1	90.5	90.7	1894	82.3	69.2	72.0	1898	87.2	88.8	76.2	1902	91.4	86.4	80.5

Acreage, production, value, and price of buckwheat in the United States, 1866–1902.

Year.	Acreage.	Average yield per acre.	Production.	Average farm price per bushel, Dec. 1.	Farm value, Dec. 1.
	Acres.	*Bushels.*	*Bushels.*	*Cents.*	*Dollars.*
1866	1,045,624	21.8	22,791,839	67.6	15,413,160
1867	1,227,826	17.4	21,359,000	78.7	16,812,070
1868	1,113,993	17.8	19,863,700	78.0	15,490,426
1869	1,028,693	16.9	17,431,100	71.9	12,534,851
1870	536,992	18.3	9,841,500	70.5	6,937,471
1871	413,915	20.1	8,328,700	74.5	6,208,165
1872	448,497	18.1	8,133,500	73.5	5,979,222
1873	454,152	17.3	7,837,700	75.0	5,878,629
1874	452,590	17.7	8,016,600	72.9	5,843,645
1875	575,530	17.5	10,082,100	62.0	6,254,564
1876	666,441	14.5	9,668,800	66.6	6,435,836
1877	649,923	15.7	10,177,000	66.9	6,808,180
1878	673,100	18.2	12,246,820	52.6	6,441,240
1879	639,900	20.5	13,140,000	59.8	7,856,191
1880	822,802	17.8	14,617,535	59.4	8,682,488
1881	828,815	11.4	9,486,200	86.5	8,205,705
1882	847,112	13.0	11,019,353	73.0	8,038,862
1883	857,349	8.9	7,668,954	82.2	6,303,980
1884	879,403	12.6	11,116,000	58.9	6,549,020
1885	914,394	13.8	12,626,000	55.9	7,057,363
1886	917,915	12.9	11,869,000	54.5	6,465,120
1887	910,506	11.9	10,844,000	56.5	6,122,320
1888	912,630	13.2	12,050,000	63.3	7,627,647
1889	837,162	14.5	12,110,329	50.5	6,113,119
1890	844,579	14.7	12,432,831	57.4	7,132,872
1891	849,364	15.0	12,760,932	57.0	7,271,506
1892	861,451	14.1	12,143,185	51.8	6,295,643
1893	815,614	14.9	12,132,311	58.4	7,074,450
1894	789,232	16.1	12,668,200	55.6	7,040,238
1895	763,277	20.1	15,341,399	45.2	6,936,325
1896	754,898	18.7	14,089,783	39.2	5,522,339
1897	717,836	20.9	14,997,451	42.1	6,319,188
1898	678,332	17.3	11,721,927	45.0	5,271,462
1899	670,148	16.6	11,094,473	55.7	6,183,675
1900	637,930	15.0	9,566,966	55.8	5,341,413
1901	811,164	18.6	15,125,939	56.3	8,523,317
1902	804,889	18.1	14,529,770	59.6	8,654,704

Acreage, production, and value of buckwheat in the United States in 1902, by States.

State.	Acreage.	Average yield per acre.	Production.	Average farm price, Dec. 1.	Average value per acre, Dec. 1.	Farm value, Dec. 1.
	Acres.	*Bushels.*	*Bushels.*	*Cents.*	*Dollars.*	*Dollars.*
Maine	25,215	30.4	766,536	52	15.81	398,599
New Hampshire	1,896	20.0	37,920	65	13.00	24,648
Vermont	10,356	25.0	258,900	56	14.00	144,984
Massachusetts	2,271	14.4	32,702	74	10.66	24,199
Connecticut	3,826	18.4	70,398	71	13.06	49,983
New York	335,015	17.7	5,929,766	59	10.44	3,498,562
New Jersey	13,404	22.5	301,590	64	14.40	193,018
Pennsylvania	247,250	18.1	4,475,225	61	11.04	2,729,887
Delaware	1,490	15.2	22,648	60	9.12	13,589
Maryland	8,291	17.0	140,947	61	10.37	85,978
Virginia	20,862	16.6	346,309	60	9.96	207,785
North Carolina	5,664	14.5	82,128	62	8.99	50,919
Tennessee	747	18.0	13,446	76	13.68	10,219
West Virginia	22,706	22.5	510,885	62	13.95	316,749
Ohio	9,669	13.9	134,399	61	8.48	81,983
Michigan	38,071	13.0	494,923	53	6.89	262,309
Indiana	6,063	17.6	106,709	58	10.21	61,891
Illinois	5,585	15.5	86,568	71	11.01	61,463
Wisconsin	27,603	16.0	441,648	59	9.44	260,572
Minnesota	4,732	13.9	65,775	57	7.92	37,492
Iowa	7,881	16.0	126,096	70	11.20	88,267
Missouri	2,119	16.1	34,116	58	9.34	19,787
Kansas	1,940	12.0	23,280	75	9.00	17,460
Nebraska	963	14.7	14,156	53	7.79	7,503
North Dakota	1,270	10.0	12,700	54	5.40	6,858
United States	804,889	18.1	14,529,770	59.6	10.75	8,654,704

Average yield per acre of buckwheat in the United States, 1893–1902, by States.

State.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.
	Bush.	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*
Maine	29.0	37.8	38.6	42.3	35.0	26.5	22.0	30.0	31.7	30.4
New Hampshire	23.2	20.0	29.9	27.2	27.0	20.0	20.0	22.0	21.0	20.0
Vermont	29.2	22.4	34.5	31.4	24.0	21.4	23.0	25.0	25.1	25.0
Massachusetts	27.5	18.9	15.0	18.3	19.0	20.0	20.0	17.0	18.9	14.4
Connecticut	15.8	16.4	15.4	14.2	17.0	19.0	19.0	16.0	18.0	18.4
New York	14.4	15.5	21.4	18.8	22.0	16.8	13.0	14.0	18.8	17.7
New Jersey	14.4	14.4	18.7	20.7	16.0	21.0	21.0	16.0	19.0	22.5
Pennsylvania	14.1	18.0	19.9	17.3	21.0	17.2	20.0	14.0	19.5	18.1
Delaware	20.0	20.0	10.0	20.0	19.0	16.5	18.0	13.0	17.8	15.2
Maryland	11.8	20.0	10.9	22.7	19.0	12.2	13.0	15.0	17.5	17.0
Virginia	13.3	14.7	10.1	18.0	14.0	17.3	14.0	13.0	15.9	16.6
North Carolina	11.5	18.7	12.0	20.0	11.0	19.5	17.0	13.0	15.6	14.5
Tennessee	12.6	12.8	10.0	24.0	18.0	18.0	12.0	14.0	14.2	18.0
West Virginia	11.5	22.6	18.8	19.5	19.0	20.5	17.0	17.0	20.6	22.5
Ohio	12.0	14.9	14.6	18.8	18.0	20.0	16.0	16.0	16.1	13.9
Michigan	13.9	12.0	17.2	15.3	17.0	14.2	11.0	14.0	14.1	13.0
Indiana	6.9	14.8	14.3	24.0	14.0	18.4	16.0	14.0	13.1	17.6
Illinois	11.6	11.7	13.3	13.8	13.0	14.0	15.0	15.0	11.0	15.5
Wisconsin	15.8	8.5	17.9	13.5	18.0	15.5	15.0	14.0	12.4	16.0
Minnesota	15.2	9.2	15.3	10.6	17.0	15.0	17.0	15.0	14.5	13.9
Iowa	13.2	13.6	13.5	16.2	17.0	16.0	16.0	15.0	13.5	16.0
Missouri	12.7	9.2	10.2	21.8	15.0	15.8	14.0	13.0	6.0	16.0
Kansas	......	......	......	......	......	......	......	......	7.9	12.0
Nebraska	14.7	3.7	6.7	21.3	14.0	12.8	16.0	16.0	11.5	14.7
North Dakota	......	......	......	......	......	......	......	......	11.5	10.0
Oregon	20.0	38.0	15.5	21.0	18.0	14.0	17.0	13.0	......	......
General average	14.9	16.0	20.1	18.7	20.9	17.3	16.6	15.0	18.6	18.1

Average value per acre of buckwheat in the United States, based upon farm value December 1, 1893–1902, by States.

State.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.
Maine	$15.66	$21.92	$17.76	$16.07	$15.40	$10.34	$9.68	$14.70	$15.22	$15.81
New Hampshire	8.58	12.20	14.05	17.20	14.85	9.40	10.00	11.44	11.55	13.00
Vermont	15.48	12.77	12.77	12.56	11.04	9.84	11.96	12.50	14.81	14.00
Massachusetts	20.63	12.85	8.85	9.70	12.54	12.20	14.00	12.24	11.53	10.66
Connecticut	11.38	10.99	8.62	7.24	9.69	10.64	11.97	10.40	11.70	13.06
New York	8.64	8.37	9.42	6.96	8.80	7.56	7.67	7.98	10.72	10.44
New Jersey	9.50	9.36	9.35	8.07	7.84	11.34	11.76	9.44	9.88	14.40
Pennsylvania	8.32	9.54	8.76	6.57	8.82	7.57	10.80	7.70	10.92	11.04
Delaware	11.00	10.00	5.00	6.00	6.84	6.60	8.82	6.76	9.79	9.12
Maryland	6.84	11.20	6.10	11.12	9.69	6.47	7.28	8.55	10.50	10.37
Virginia	7.31	7.94	5.45	8.46	7.00	7.79	7.56	7.15	8.90	9.96
North Carolina	5.63	8.79	5.28	12.00	5.39	9.36	8.33	7.28	9.67	8.99
Tennessee	6.80	7.30	5.40	14.88	10.26	9.36	6.84	8.26	8.38	13.68
West Virginia	7.82	14.01	10.72	9.75	9.31	10.05	9.52	9.52	12.15	13.95
Ohio	7.20	9.83	8.03	8.08	9.00	10.20	9.28	9.28	9.66	8.48
Michigan	7.37	6.60	7.40	5.81	6.46	5.96	6.05	7.14	7.19	6.89
Indiana	3.86	8.29	8.29	12.24	6.86	9.38	9.44	8.54	7.99	10.21
Illinois	6.61	9.01	5.85	6.21	7.41	7.28	8.70	9.75	7.70	11.01
Wisconsin	9.01	4.76	8.23	5.13	6.84	6.20	9.45	8.26	7.32	9.44
Minnesota	8.06	5.43	7.80	4.35	7.65	7.35	8.84	8.55	8.99	7.92
Iowa	8.05	10.20	6.75	7.45	8.33	7.69	9.28	9.60	9.45	11.20
Missouri	7.37	5.52	5.92	15.26	9.00	9.48	8.54	8.97	4.56	9.34
Kansas	......	......	......	......	......	......	......	......	5.92	9.00
Nebraska	7.64	2.52	4.36	10.65	7.14	7.81	9.92	10.24	6.67	7.79
North Dakota	......	......	......	......	......	......	......	......	6.90	5.40
Oregon	10.00	20.90	7.75	14.28	9.90	8.12	12.58	10.01	......	......
General average	8.67	8.92	9.09	7.32	8.80	7.77	9.23	8.37	10.51	10.75

Average farm price of buckwheat per bushel in the United States, December 1, 1893–1902, by States.

State.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
Maine	54	58	46	38	44	39	44	49	48	52
New Hampshire	37	61	47	63	55	47	50	52	55	65
Vermont	53	57	37	40	46	46	52	50	59	56
Massachusetts	75	68	59	53	66	61	70	72	61	74
Connecticut	72	67	56	51	57	56	63	65	65	71
New York	60	54	44	37	40	45	59	57	57	59
New Jersey	66	65	50	39	49	54	56	59	52	64
Pennsylvania	59	53	44	38	42	44	54	55	56	61
Delaware	55	50	50	30	36	40	49	52	55	60
Maryland	58	56	56	49	51	53	56	57	60	61
Virginia	55	54	54	47	50	45	54	55	56	60
North Carolina	49	47	44	60	49	48	49	56	62	62
Tennessee	54	57	54	62	57	52	57	59	59	76
West Virginia	68	62	57	50	49	49	56	56	59	62
Ohio	60	66	55	43	50	51	53	58	60	61
Michigan	53	55	43	38	38	42	55	51	51	53
Indiana	56	56	58	51	49	51	59	61	61	58
Illinois	57	77	44	45	57	52	58	65	70	71
Wisconsin	57	56	46	38	38	40	63	59	59	59
Minnesota	53	59	51	41	45	49	52	57	62	57
Iowa	61	75	50	46	49	48	58	64	70	70
Missouri	58	60	58	70	60	60	61	69	76	58
Kansas	......	......	......	......	......	......	......	......	75	75
Nebraska	52	68	65	50	51	61	62	64	58	53
North Dakota	......	......	......	......	......	......	......	......	60	54
Oregon	50	55	50	68	55	58	74	77	......	......
General average	58.4	55.6	45.2	39.2	42.1	45.0	55.7	55.8	56.3	59.6

POTATOES.

The production of potatoes in the United States during 1902 reached 284,632,787 bushels and exceeded the yield in any preceding year excepting 1895. The acreage was the highest ever recorded, and the average yield per acre of 96 bushels was the highest in twenty years, with the exception of the yield of 100 bushels per acre for the high-crop year of 1895.

Wholesale prices ranged from 68 to 80 cents at Chicago in the first three months of the year, reached \$1 in April and May, and then reacted, but were fairly well maintained.

Condition of the potato crop of the United States, monthly, 1887–1902.

Year.	July.	Aug.	Sept.	Oct.	Year.	July.	Aug.	Sept.	Oct.
1887	93.2	80.8	67.3	61.5	1895	91.5	89.7	90.8	87.4
1888	95.7	93.2	91.6	86.8	1896	99.0	94.8	83.2	81.7
1889	95.1	94.3	81.7	77.9	1897	87.8	77.9	66.7	61.6
1890	91.7	77.4	65.7	61.7	1898	95.5	83.9	77.7	72.5
1891	95.3	96.5	91.8	91.3	1899	93.8	93.0	86.3	81.7
1892	90.0	86.8	74.8	67.7	1900	91.3	88.2	80.0	74.4
1893	94.8	86.0	71.8	71.2	1901	87.4	62.3	52.2	54.0
1894	92.3	74.0	62.4	64.3	1902	92.9	94.8	89.1	82.5

Acreage, production, value, prices, exports, and imports of potatoes of the United States, 1866–1902.

Year.	Acreage.	Average yield per acre.	Production.	Average farm price per bushel, Dec. 1	Farm value, Dec. 1.	Chicago price per bushel, Burbank. December. Low.	December. High.	May of following year. Low.	May of following year. High.	Domestic exports, fiscal years beginning July 1.	Imports during fiscal years beginning July 1.
	Acres.	*Bush.*	*Bushels.*	*Cts.*	*Dollars.*	*Cts.*	*Cts.*	*Cts.*	*Cts.*	*Bushels.*	*Bushels.*
1866	1,069,381	100.2	107,200,976	47.3	50,722,553	......	......	......	......	512,380	198,265
1867	1,192,195	82.0	97,783,000	65.9	64,462,486	......	......	......	......	378,605	209,555
1868	1,131,552	93.8	106,090,000	59.3	62,918,660	......	......	......	......	508,249	138,470
1869	1,222,250	109.5	133,886,000	42.9	57,481,362	......	......	......	......	596,968	75,336
1870	1,325,119	86.6	114,775,000	65.0	74,621,019	......	......	......	......	553,070	458,758
1871	1,220,912	98.7	120,461,700	53.9	64,905,189	......	......	......	......	621,537	96,259
1872	1,331,331	85.3	113,516,000	53.5	60,692,129	......	......	......	......	515,306	316,840
1873	1,295,139	81.9	106,089,000	65.2	69,153,709	......	......	......	......	497,413	549,073
1874	1,310,041	80.9	105,981,000	61.5	65,223,314	......	......	......	......	609,642	188,757
1875	1,510,041	110.5	166,877,000	34.4	57,357,515	......	......	......	......	701,379	92,148
1876	1,741,983	71.7	124,827,000	61.9	77,319,541	......	......	......	......	529,650	3,205,555
1877	1,792,287	94.9	170,092,000	43.7	74,272,560	......	......	......	......	744,409	528,584
1878	1,776,800	69.9	124,126,650	58.7	72,923,575	......	......	......	......	625,342	2,624,149
1879	1,836,800	98.9	181,626,400	43.6	79,153,673	......	......	......	......	696,080	721,868
1880	1,842,510	91.0	167,659,570	48.3	81,062,214	......	......	......	......	638,840	2,170,372
1881	2,041,670	53.5	109,145,494	91.0	99,291,341	......	......	......	......	408,286	8,789,860
1882	2,171,635	78.7	170,972,508	55.7	95,304,844	......	......	......	......	439,443	2,362,362
1883	2,289,275	90.9	208,164,425	42.2	87,848,991	......	......	......	......	554,613	425,408
1884	2,220,980	85.8	190,642,000	39.6	75,524,290	......	......	......	......	380,868	658,633
1885	2,265,823	77.2	175,029,000	44.7	78,153,403	......	......	33	50	494,948	1,937,416
1886	2,287,136	73.5	168,051,000	46.7	78,441,940	44	47	65	90	434,864	1,432,490
1887	2,357,322	56.9	134,103,000	68.2	91,506,740	70	83	65	85	403,880	8,259,538
1888	2,533,280	79.9	202,365,000	40.2	81,413,589	30	37	24	45	471,955	883,380
1889	2,647,989	77.4	204,990,345	35.5	72,704,413	33	45	30	60	406,618	3,415,578
1890	2,651,579	55.8	148,078,945	75.8	112,205,235	82	93	95	110	311,189	5,401,912
1891	2,714,770	93.7	254,426,971	35.8	91,024,521	30	40	30	50	557,022	186,871
1892	2,547,962	61.5	156,654,819	66.1	103,567,520	60	72	70	98	845,720	4,317,021
1893	2,605,186	70.3	183,034,203	59.4	108,661,801	51	60	64	88	803,111	8,002,578
1894	2,737,973	62.4	170,787,338	53.6	91,526,787	43	58	40	70	572,957	1,341,533
1895	2,954,952	100.6	297,237,370	26.6	78,984,901	18	24	10	23	680,049	175,240
1896	2,767,465	91.1	252,234,540	28.6	72,182,350	18	26	19	26	926,646	246,178
1897	2,534,577	64.7	164,015,964	54.7	89,643,059	50	62	60	87	605,187	1,171,378
1898	2,557,729	75.2	192,306,338	41.4	79,574,772	30	36	......	......	579,833	530,420
1899	2,581,353	88.6	228,783,232	39.0	89,328,832	......	......	......	......	809,472	155,861
1900	2,611,054	80.8	210,926,897	43.1	90,811,167	......	......	......	......	741,483	371,911
1901	2,864,335	65.5	187,598,087	76.7	143,979,470	......	......	......	......	628,484	7,656,162
1902	2,965,587	96.0	284,632,787	47.1	134,111,436	......	......	......	......	....	....

Acreage, production, and value of potatoes in the United States in 1902, by States.

States and Territories.	Acreage.	Yield per acre.	Production.	Price per bushel.	Total value.
	Acres.	*Bushels.*	*Bushels.*	*Cents.*	*Dollars.*
Maine	80,627	130	10,481,510	65	6,812,982
New Hampshire	18,650	120	2,238,000	69	1,544,220
Vermont	27,133	94	2,550,502	58	1,479,291
Massachusetts	29,166	109	3,179,094	81	2,575,066
Rhode Island	6,442	164	1,056,488	75	792,366
Connecticut	29,032	92	2,670,944	73	1,949,789
New York	407,082	66	26,867,412	59	15,851,773
New Jersey	57,113	132	7,538,916	61	4,598,739
Pennsylvania	246,619	83	20,469,377	57	11,667,545
Delaware	6,000	79	474,000	51	241,740
Maryland	28,801	80	2,304,080	52	1,198,122
Virginia	50,531	75	3,789,825	58	2,198,098
North Carolina	24,890	64	1,592,960	67	1,067,283
South Carolina	8,470	69	584,430	96	561,053
Georgia	8,715	58	505,470	90	454,923
Florida	3,524	90	317,160	122	386,935
Alabama	9,548	50	477,400	93	443,982
Mississippi	5,870	69	405,030	92	372,628
Louisiana	8,306	65	539,890	82	442,710
Texas	26,704	66	1,762,464	85	1,498,094
Arkansas	25,637	72	1,845,864	68	1,255,188
Tennessee	26,405	62	1,637,110	64	1,047,750
West Virginia	32,192	96	3,090,432	51	1,576,120
Kentucky	38,068	80	3,045,440	53	1,614,083
Ohio	165,252	94	15,533,688	44	6,834,823
Michigan	270,939	72	19,507,608	41	7,998,119
Indiana	82,860	101	8,368,860	41	3,431,233
Illinois	146,295	118	17,262,810	42	7,250,380
Wisconsin	250,022	115	28,752,530	33	9,488,335
Minnesota	137,270	98	13,452,460	31	4,170,263
Iowa	173,129	98	16,966,642	34	5,768,658
Missouri	95,579	128	12,234,112	35	4,281,939
Kansas	77,573	138	10,705,074	45	4,817,283
Nebraska	82,244	137	11,267,428	27	3,042,206
South Dakota	31,801	74	2,353,274	44	1,035,441
North Dakota	23,725	105	2,491,125	33	822,071
Montana	11,521	153	1,762,713	50	881,356
Wyoming	3,702	107	396,114	61	241,630
Colorado	47,437	100	4,743,700	51	2,419,287
New Mexico	1,224	72	88,128	81	71,384
Arizona	....	....	....	....	....
Utah	10,609	157	1,665,613	45	749,526
Nevada	2,357	212	499,684	63	314,801
Idaho	11,790	149	1,756,710	37	649,983
Washington	31,288	136	4,255,168	38	1,616,964
Oregon	35,724	103	3,679,572	55	2,023,765
California	47,975	118	5,661,050	58	3,283,409
Oklahoma	10,543	97	1,022,671	77	787,457
Indian Territory	9,203	85	782,255	64	500,643
United States	2,965,587	96.0	284,632,787	47.1	134,111,436

Average yield per acre of potatoes in the United States, 1893–1902, by States.

States and Territories.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.
	Bush.	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*
Maine	120	147	163	165	59	130	139	126	150	130
New Hampshire	119	120	134	108	51	90	127	101	108	120
Vermont	111	124	154	128	70	105	132	134	90	94
Massachusetts	119	105	133	108	62	97	134	79	77	109
Rhode Island	108	133	138	105	110	123	142	94	98	164
Connecticut	87	79	128	106	54	100	130	96	81	92
New York	70	77	122	89	62	73	88	81	78	66
New Jersey	73	60	94	94	68	75	83	69	59	132
Pennsylvania	76	64	111	109	63	54	85	58	62	83
Delaware	50	50	58	78	60	49	52	48	55	79
Maryland	49	52	87	90	74	58	64	55	60	80
Virginia	74	59	73	93	61	68	66	58	71	75
North Carolina	97	62	79	79	66	67	57	61	64	64
South Carolina	83	59	90	52	65	65	56	78	70	69
Georgia	74	52	58	55	52	54	46	68	64	58
Florida	87	90	55	75	75	64	69	60	62	90
Alabama	83	43	70	64	55	74	56	69	67	50
Mississippi	81	72	58	70	59	74	61	66	62	69
Louisiana	67	45	89	55	64	78	60	70	60	65
Texas	53	80	89	52	60	78	61	62	54	66
Arkansas	88	82	70	59	55	74	63	72	46	72
Tennessee	68	55	64	62	40	52	44	54	46	62
West Virginia	80	52	69	93	56	62	72	80	52	96
Kentucky	68	54	86	85	47	64	51	70	25	80
Ohio	58	63	63	89	42	61	71	76	54	94

Average yield per acre of potatoes in the United States, 1893–1902, by States—Continued.

States and Territories.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.
	Bush.	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*
Michigan	75	62	101	88	72	79	66	97	81	72
Indiana	51	59	66	85	31	71	76	83	31	101
Illinois	53	50	77	97	38	79	96	92	35	118
Wisconsin	77	45	107	78	99	98	103	103	75	115
Minnesota	66	39	158	84	106	85	96	81	68	98
Iowa	58	43	106	94	60	80	100	72	32	98
Missouri	78	69	109	78	42	66	82	93	17	128
Kansas	44	41	72	69	48	70	95	72	26	138
Nebraska	44	22	67	90	69	65	94	66	33	137
South Dakota	54	23	66	96	94	72	78	73	45	74
North Dakota	69	84	128	102	99	87	103	52	110	105
Montana	138	111	53	170	156	104	141	134	157	153
Wyoming	134	150	100	167	150	120	125	99	113	100
Colorado	94	85	95	88	97	77	84	56	120	100
New Mexico	70	75	80	72	90	58	49	19	50	72
Utah	88	135	172	155	148	135	120	118	114	157
Nevada	132	161	150	190	135	155	102	156	141	212
Idaho	153	178	105	162	140	120	124	136	108	149
Washington	120	125	149	125	162	108	144	116	117	136
Oregon	127	112	64	87	160	86	115	110	99	103
California	96	52	75	80	105	95	119	104	101	118
Oklahoma	......	......	......	......	......	......	......	......	55	97
Indian Territory	......	......	......	......	......	......	......	......	63	85
General average	70.3	62.4	100.6	91.1	64.7	75.2	88.6	80.8	65.5	96.0

Average value per acre of potatoes in the United States, based upon farm values December 1, 1893–1902, by States.

States and Territories.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.
Maine	$64.80	$64.68	$55.42	$62.70	$52.51	$59.80	$58.38	$61.74	$100.50	$84.50
New Hampshire	74.97	56.40	42.88	50.76	45.90	44.10	58.42	53.53	85.32	82.80
Vermont	53.28	54.56	40.04	37.12	49.00	44.10	47.52	53.60	57.60	54.52
Massachusetts	90.44	68.25	63.84	61.56	55.80	61.11	76.38	52.14	69.30	88.29
Rhode Island	85.32	95.76	62.10	56.70	106.70	78.72	71.00	65.80	91.14	123.00
Connecticut	65.25	53.72	52.48	48.76	48.60	55.00	59.80	67.20	76.14	67.16
New York	38.50	36.96	28.06	27.59	41.54	30.66	35.20	36.45	55.38	33.94
New Jersey	54.75	37.20	31.96	33.84	53.04	45.75	42.33	41.40	50.15	80.52
Pennsylvania	45.60	36.48	31.08	29.43	41.58	31.32	36.55	30.74	47.12	47.31
Delaware	32.50	25.00	22.04	27.30	39.00	33.81	26.52	28.80	42.90	40.29
Maryland	33.32	27.56	26.10	27.00	50.32	30.74	32.64	29.70	46.20	41.60
Virginia	47.88	33.04	27.74	31.62	42.70	37.40	36.96	34.22	52.54	43.50
North Carolina	58.20	37.20	43.45	33.97	42.24	41.54	37.62	39.65	46.08	42.88
South Carolina	63.91	45.43	65.70	34.32	68.25	65.00	58.24	78.00	77.00	66.24
Georgia	68.08	42.12	41.18	41.25	52.00	40.50	38.18	52.36	67.84	52.20
Florida	101.79	67.50	55.00	63.00	90.00	76.80	85.56	63.60	79.98	109.80
Alabama	73.04	37.84	56.70	48.00	51.70	61.42	48.72	56.58	73.03	46.50
Mississippi	68.04	59.04	37.12	43.40	48.38	53.28	62.22	54.78	71.30	63.48
Louisiana	55.61	37.35	64.08	41.80	54.40	58.50	48.60	55.30	60.60	53.30
Texas	54.59	79.20	69.42	40.56	57.00	67.08	58.24	54.56	67.50	56.10
Arkansas	56.32	43.46	35.70	31.27	46.20	40.70	44.73	41.04	57.96	48.96
Tennessee	33.32	26.95	25.60	24.80	29.20	29.64	28.60	31.32	39.56	39.68
West Virginia	47.20	29.64	28.98	28.83	36.40	33.48	37.44	40.80	44.20	48.96
Kentucky	38.08	30.24	33.54	28.05	31.49	29.44	31.11	35.00	30.45	42.40
Ohio	38.86	32.76	20.16	24.14	26.04	25.01	30.53	30.40	45.90	41.36
Michigan	33.75	26.66	16.16	16.72	30.96	21.33	21.12	25.22	55.08	29.52
Indiana	37.23	31.86	20.46	21.25	19.22	29.11	32.68	31.54	27.90	41.41
Illinois	39.22	32.00	23.10	25.22	23.56	32.20	39.36	37.72	32.55	49.56
Wisconsin	37.73	23.85	18.19	14.82	37.62	23.52	26.78	28.84	50.25	37.95
Minnesota	30.36	19.89	22.12	17.64	32.86	21.25	24.00	24.30	45.56	30.38
Iowa	37.70	29.67	20.14	20.68	28.20	24.00	23.00	26.64	30.08	33.32
Missouri	44.46	35.88	27.25	24.18	26.46	29.04	33.20	32.55	18.02	44.80
Kansas	34.76	27.88	30.24	18.63	26.40	35.70	42.75	34.56	27.04	62.10
Nebraska	34.76	16.94	20.10	22.50	31.74	24.05	23.50	32.34	34.65	36.99
South Dakota	31.86	17.02	17.16	19.20	30.08	20.16	21.06	26.28	38.25	32.56
North Dakota	33.81	38.64	21.75	21.42	32.67	29.58	27.81	25.48	53.90	34.65
Montana	95.22	53.28	25.44	54.40	62.40	57.20	74.73	71.02	114.61	76.50
Wyoming	87.10	90.00	56.00	71.81	82.50	78.00	76.25	67.32	112.40	65.27
Colorado	50.76	46.75	31.35	41.36	54.32	41.58	46.20	45.92	108.00	51.00
New Mexico	46.90	60.00	50.40	48.96	70.20	45.24	33.32	21.66	59.00	58.32
Utah	29.04	40.50	58.48	49.60	44.40	41.85	66.00	56.64	68.40	70.65
Nevada	52.80	56.35	57.00	72.20	98.55	139.50	91.80	87.36	128.31	133.56
Idaho	85.68	94.34	42.00	48.60	44.80	64.80	75.64	63.92	90.72	55.13
Washington	46.80	35.00	41.72	50.00	45.36	42.14	72.00	54.52	71.37	51.68
Oregon	59.69	40.32	24.96	33.93	64.00	40.42	56.35	49.50	63.00	56.65
California	48.00	25.48	36.00	42.40	51.45	52.25	74.97	55.12	77.77	68.44
Oklahoma	......	......	......	......	......	......	......	......	69.30	74.69
Indian Territory	......	......	......	......	......	......	......	......	78.12	54.40
General average	41.71	33.43	26.73	26.08	35.37	31.11	34.60	34.78	50.27	45.22

Average farm price of potatoes per bushel in the United States December 1, 1893–1902, by States.

States and Territories.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
Maine	54	44	34	38	89	46	42	49	67	65
New Hampshire	63	47	32	47	90	49	46	53	79	69
Vermont	48	44	26	29	70	42	36	40	64	58
Massachusetts	76	65	48	57	90	63	57	66	90	81
Rhode Island	79	72	45	54	97	64	50	70	93	75
Connecticut	75	68	41	46	90	55	46	70	94	73
New York	55	48	23	31	67	42	40	45	71	59
New Jersey	75	62	34	36	78	61	51	60	85	61
Pennsylvania	60	57	28	27	66	58	43	53	76	57
Delaware	65	50	38	35	65	69	51	60	78	51
Maryland	68	53	30	30	68	53	51	54	77	52
Virginia	57	56	38	34	70	55	56	59	74	58
North Carolina	60	60	55	43	64	62	66	65	72	67
South Carolina	77	77	73	66	105	100	104	100	110	96
Georgia	92	81	71	75	100	75	83	77	106	90
Florida	117	75	100	84	120	120	124	106	129	122
Alabama	88	88	81	75	94	83	87	82	109	93
Mississippi	84	82	64	62	82	72	102	83	115	92
Louisiana	83	83	72	76	85	75	81	79	101	82
Texas	103	99	78	78	95	86	91	88	125	85
Arkansas	64	53	51	53	84	55	71	57	126	63
Tennessee	49	49	40	40	73	57	65	58	86	64
West Virginia	59	57	42	31	65	54	52	51	85	51
Kentucky	56	56	39	33	67	46	61	50	87	53
Ohio	67	52	32	26	62	41	43	40	85	44
Michigan	45	43	16	19	43	27	32	26	68	41
Indiana	73	54	31	25	62	41	43	38	90	41
Illinois	74	64	30	26	62	46	41	41	93	42
Wisconsin	49	53	17	19	38	24	26	28	67	33
Minnesota	46	51	14	21	31	25	25	30	67	31
Iowa	65	69	19	22	47	30	23	37	94	34
Missouri	57	52	25	31	63	44	40	35	106	35
Kansas	79	68	42	27	55	51	45	48	104	45
Nebraska	79	77	30	25	46	37	25	49	105	27
South Dakota	59	74	26	20	32	28	27	36	85	44
North Dakota	49	46	17	21	33	34	27	49	49	33
Montana	69	48	48	32	40	55	53	53	73	50
Wyoming	65	60	56	43	55	65	61	68	100	61
Colorado	54	55	33	47	56	54	55	82	90	51
New Mexico	67	80	63	68	78	78	68	114	118	81
Utah	33	30	34	32	30	31	55	48	60	45
Nevada	40	35	38	38	73	90	90	56	91	63
Idaho	56	53	40	30	32	54	61	47	84	37
Washington	39	28	28	40	28	39	50	47	61	38
Oregon	47	36	39	39	40	47	49	45	70	55
California	50	49	48	53	49	55	63	53	77	58
Oklahoma	......	......	......	......	......	......	......	......	126	77
Indian Territory	......	......	......	......	......	......	......	......	124	64
General average	59.4	53.6	26.6	28.6	54.7	41.4	39.0	43.1	76.7	47.1

EXPORTS AND IMPORTS OF POTATOES.

The United States usually raises very nearly the quantity of potatoes needed for home use. The exports and imports, averaging a little more than a half a million bushels each way, offset each other and probably represent largely the ordinary interchange between this country and Canada. But in the twelve months ended June 30, 1902, the imports suddenly ran up to 7,656,162 bushels, worth $3,160,801. This was due to a shortage in the United States crop of 1901 caused by extreme dry weather. The total crop was 187,598,087 bushels, a decrease from 1900 of 23,328,810 bushels.

The potato crop of Germany in 1901 was 1,788,950,112, an increase of 297,695,400 over 1900; in Ireland it was 125,895,989 bushels, an increase of 57,134,261 bushels; in Russia 879,710,734, a decrease of 82,556,576 bushels.

Wholesale prices of potatoes per bushel in leading cities of the United States, 1898–1902.

Date.	Cincinnati.		Chicago.		Milwaukee.		St. Louis.	
	Per barrel.		Burbank, per bushel.		Per bushel.		Burbank, per bushel.	
	Low.	High.	Low.	High.	Low.	High.	Low.	High.
1898.			*Cents.*		*Cents.*		*Cents.*	
January	$2.00	$2.25	57	$0.62	45	$0.55	60	$0.68
February	....	....	57	.64	50	.60	62	.68
March	....	....	60	.67	50	.60	58	.70
April	....	....	58	.66	45	.75	52½	.75
May	2.80	3.75	60	.87	50	.90	60	.85
June	2.25	2.75	32	.65	35	.65	55	.70
July	1.50	2.50	44	.50	35	.80	40	.50
August	1.25	1.75	....	....	35	.50	....	....
September	1.25	1.75	32	.48	30	.40	35	.50
October	1.25	1.60	29	.36	25	.35	35	.43
November	1.25	1.35	29	.35	25	.30	30	.41
December	....	....	30	.36	25	.30	33	.40
1899.								
January	....	....	34	.38	20	.35	39½	.45
February	....	....	34	.50	20	.45	42	.55
March	....	....	48	.75	30	.65	53	.75
April	....	....	49	.68	40	.60	56	.72
May	2.00	6.00	33	.52	20	.55	40	.55
June	1.50	2.50	34	.60	15	.40	42	.52
July	1.15	2.00	28	.28	20	.90	....	....
August	1.10	1.50	....	....	20	.35	25	.30
September	1.40	1.60	30	.40	20	.30	32	.40
October	....	....	26	.32	18	.30	32	.40
November	....	....	31	.42	18	.35	33	.44
December	....	....	35	.46	25	.40	43	.48
1900.	Per bushel.							
January	.45	.57	42	.50	25	.40	43	.52
February	.45	.55	40	.49	25	.42	43	.50
March	.43	.50	33	.45	25	.45	35	.46
April	.32	.45	26	.37	20	.38	27	.40
May	.33	.50	27	.39	20	.35	30	.45
June	.35	.50	31	.41	20	.80	36	.45
July	....	....	....	....	20	.55	....	....
August	....	....	....	....	30	.40	....	....
September	40	.45	30	.40	28	.38	32	.40
October	.32	.40	25	.34	23	.35	32	.38
November	.38	.47	29	.46	23	.42	33	.48
December	.40	.50	40	.48	30	.50	45	.54
1901.								
January	.42	.50	40	.49	35	.50	45	.54
February	.40	.48	38	.43	37	.50	18	.20
March	.30	.47	33	.42	32	.45	37	.43
April	.35	.45	30	.42	28	.45	41	.45
May	.38	.75	35	.60	30	.60	39	.53
June	.64	.90	35	.78	30	.70	50	.80
July	....	....	....	....	25	1.20	....	....
August	.95	1.10	95	1.25	75	1.85	....	....
September	.75	1.20	56	1.07	40	1.00	70	1.40
October	.40	.75	59	.68	50	.75	70	.75
November	.60	.95	59	.82	60	.80	83	1.00
December	.78	.90	75	.82	65	.87	83	.83
1902.	Per barrel.							
January	2.20	2.40	70	.80	....	....	78	.83
February	2.10	2.40	68	.76	....	....	78	.84
March	2.10	2.60	68	.80	....	....	76	.90
April	2.45	3.00	72	1.00	....	....	81	1.05
May	2.25	3.00	54	1.00	....	....	90	1.05
June	2.10	2.40	47	.60	....	....	72	.80
July	.90	2.40	....	....	....	....	....	....
August	.90	1.05	....	....	....	....	....	....
September	.95	1.35	30	.38	....	....	....	....
October	1.25	1.35	30	.44	....	....	41	.44
November	1.50	1.60	42	.48	....	....	50	.54
December	1.35	1.50	42	.48	....	....	51	.55

HAY.

A yield of 59,857,576 tons of hay in the United States during the year 1902 was the largest since 1898, and an average yield per acre of 1½ tons was the highest reported with the exception of the record year of 1898. The average yield in the eleven principal hay-producing States was in excess of last year, and also in excess of the ten-year average.

Prices of baled hay ruled higher than for several years; $10 to $17.50 in Chicago, $11 to $16.50 in Cincinnati, and $9.50 to $16 in St. Louis.

Condition of hay crop in United States, monthly, 1887–1902.

Year.	Clover.		Timothy.		Year.	Clover.		Timothy.	
	June.	July.	July.	Aug.		June.	July.	July.	Aug.
1887	....	....	....	80.6	1895	82.8	73.9	70.8	69.9
1888	....	....	....	....	1896	88.4	83.7	84.8	87.5
1889	....	....	....	94.5	1897	96.0	....	....	....
1890	95.1	94.0	93.9	93.6	1898	....	....	....	99.3
1891	91.0	89.3	87.4	90.9	1899	....	....	....	86.7
1892	94.9	95.5	96.8	93.2	1900	....	....	....	79.9
1893	92.7	92.6	89.8	89.6	1901	....	....	....	84.1
1894	87.8	80.2	77.3	75.6	1902	....	86.3	84.9	90.0

Acreage, production, value, prices, and exports of hay of the United States, 1866–1902.

Year.	Acreage.	Average yield per acre.	Production.	Average farm price per ton Dec. 1.	Farm value Dec. 1.	Chicago prices of No. 1 timothy by carload lots.				Domestic exports, fiscal years beginning July 1.
						December.		May of following year.		
						Low.	High.	Low.	High.	
	Acres.	*Tons.*	*Tons.*	*Dolls.*	*Dollars.*	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*	*Tons.*
1866	17,668,904	1.23	21,778,627	10.14	220,835,771	....	....	....	....	5,028
1867	20,020,554	1.31	26,277,000	10.21	268,300,623	....	....	....	....	5,645
1868	21,541,573	1.21	26,141,900	10.08	263,589,235	....	....	....	....	....
1869	18,591,281	1.42	26,420,000	10.18	268,933,048	....	....	....	....	6,723
1870	19,861,805	1.23	24,525,000	12.47	305,743,224	....	....	....	....	4,581
1871	19,009,052	1.17	22,239,400	14.30	317,939,799	....	....	....	....	5,266
1872	20,318,936	1.17	23,812,800	12.94	308,024,517	....	....	....	....	4,557
1873	21,894,084	1.15	25,085,100	12.53	314,241,037	....	....	....	....	4,889
1874	21,769,772	1.15	25,133,900	11.94	300,222,451	....	....	....	....	7,183
1875	23,507,964	1.19	27,873,600	10.78	300,377,839	....	....	....	....	7,528
1876	25,282,797	1.22	30,867,100	8.97	276,991,422	....	....	9.00	10.00	7,287
1877	25,367,708	1.25	31,629,300	8.37	264,879,796	9.50	10.50	9.75	10.75	9,514
1878	26,931,300	1.47	39,608,296	7.20	285,015,625	8.00	8.50	9.00	11.50	8,127
1879	27,484,991	1.29	35,493,000	9.32	330,804,494	14.00	14.50	14.00	15.00	13,739
1880	25,863,955	1.23	31,925,233	11.65	371,811,084	15.00	15.50	17.00	19.00	12,662
1881	30,888,700	1.14	35,135,064	11.82	415,131,366	16.00	16.50	15.00	16.50	10,570
1882	32,339,585	1.18	38,138,049	9.70	369,958,158	11.50	12.25	12.00	13.00	13,309
1883	35,515,948	1.32	46,864,009	8.19	383,834,451	9.00	10.00	12.50	17.00	16,908
1884	38,571,593	1.26	48,470,460	8.17	396,139,309	10.00	11.50	15.50	17.50	11,142
1885	39,849,701	1.12	44,731,550	8.71	389,752,873	11.00	12.00	10.00	12.00	13,390
1886	36,501,688	1.15	41,796,499	8.46	353,437,699	9.50	10.50	11.00	12.50	13,873
1887	37,664,739	1.10	41,454,458	9.97	413,440,283	13.50	14.50	17.00	21.00	18,198
1888	38,591,903	1.21	46,643,094	8.76	408,499,565	11.00	11.50	10.50	11.00	21,928
1889	52,947,236	1.26	66,829,612	7.04	470,374,948	9.00	10.00	9.00	14.00	36,274
1890	50,712,513	1.19	60,197,589	7.87	473,569,972	9.00	10.50	12.50	15.50	28,066
1891	51,044,490	1.19	60,817,771	8.12	494,113,616	12.50	15.00	13.50	14.00	35,201
1892	50,853,061	1.18	59,823,735	8.20	490,427,798	11.00	11.50	12.00	13.50	33,084
1893	49,613,469	1.33	65,766,158	8.68	570,882,872	10.00	10.50	10.00	10.50	54,446
1894	48,321,272	1.14	54,874,408	8.54	468,578,321	10.00	11.00	10.00	10.25	47,117
1895	44,206,453	1.06	47,078,541	8.35	393,185,615	12.00	12.50	11.50	12.00	59,052
1896	43,259,756	1.37	59,282,158	6.55	388,145,614	8.00	8.50	8.50	9.00	61,658
1897	42,426,770	1.43	60,664,876	6.62	401,390,728	8.00	8.50	9.50	10.50	81,827
1898	42,780,827	1.55	66,376,920	6.00	398,060,647	8.00	8.25	9.50	10.50	64,916
1899	41,328,462	1.35	56,655,756	7.27	411,926,187	10.50	11.50	10.50	12.50	72,716
1900	39,132,890	1.28	50,110,906	8.89	445,538,870	11.50	14.00	12.00	13.50	89,364
1901	39,390,508	1.28	50,590,877	10.01	506,191,553	12.50	13.90	13.00	14.00	153,431
1902	39,825,227	1.50	59,857,576	9.06	542,036,364	12.00	13.00	....	....	....

Acreage, production, and value of hay in the United States in 1902, by States.

States and Territories.	Acreage.	Yield per acre.	Production.	Price per ton.	Farm value.
	Acres.	Tons.	Tons.	Dollars.	Dollars.
Maine	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
New Hampshire	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Vermont	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Massachusetts	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Rhode Island	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Connecticut	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
New York	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
New Jersey	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pennsylvania	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Delaware	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Maryland	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Virginia	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
North Carolina	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
South Carolina	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Georgia	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Florida	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Alabama	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Mississippi	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Louisiana	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Texas	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Arkansas	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Tennessee	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
West Virginia	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Kentucky	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ohio	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Michigan	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Indiana	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Illinois	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Wisconsin	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Minnesota	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Iowa	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Missouri	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Kansas	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Nebraska	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
South Dakota	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
North Dakota	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Montana	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Wyoming	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Colorado	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
New Mexico	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Arizona	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Utah	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Nevada	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Idaho	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Washington	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Oregon	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
California	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Oklahoma	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Indian Territory	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
United States	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Average yield per acre of hay in the United States, 1893–1902, by States.

States and Territories.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.
	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
Maine	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
New Hampshire	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Vermont	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Massachusetts	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Rhode Island	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Connecticut	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
New York	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
New Jersey	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pennsylvania	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Delaware	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Maryland	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Virginia	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
North Carolina	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
South Carolina	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Georgia	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Florida	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Alabama	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Mississippi	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Louisiana	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Texas	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Average yield per acre of hay in the United States, 1893–1902, by States—Continued.

States and Territories.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Arkansas	1.17	1.32	1.20	1.18	1.30	1.54	1.48	1.63	1.10	1.60
Tennessee	1.39	1.18	1.39	1.40	1.45	1.50	1.31	1.40	1.52	1.44
West Virginia	1.10	1.02	.71	1.22	1.35	1.54	1.29	1.18	1.37	1.12
Kentucky	1.33	1.26	1.35	1.20	1.17	1.45	1.29	1.49	1.34	1.44
Ohio	1.33	1.27	.58	1.26	1.44	1.39	1.30	1.06	1.36	1.43
Michigan	1.46	1.20	.58	1.16	1.49	1.36	1.22	1.29	1.26	1.45
Indiana	1.36	1.27	.61	1.30	1.43	1.45	1.34	1.21	1.27	1.46
Illinois	1.21	1.14	.66	1.38	1.29	1.56	1.29	1.27	1.08	1.50
Wisconsin	1.52	1.31	.88	1.25	1.35	1.59	1.47	1.15	1.29	1.99
Minnesota	1.62	1.02	1.30	1.69	1.57	1.80	1.70	1.16	1.55	1.76
Iowa	1.58	.73	1.08	1.74	1.50	1.75	1.34	1.42	1.25	1.68
Missouri	1.24	.85	1.17	1.43	1.15	1.60	1.37	1.29	.75	1.59
Kansas	1.31	.77	1.24	1.42	1.30	1.46	1.57	1.32	.91	1.70
Nebraska	1.25	.59	.99	1.66	1.60	1.60	1.66	1.38	1.25	1.74
South Dakota	1.42	.94	.79	1.28	1.25	1.38	1.43	1.18	1.15	1.23
North Dakota	1.29	1.19	1.42	1.65	1.60	1.50	1.58	.92	1.60	1.66
Montana	1.26	1.20	.94	1.38	1.50	1.45	1.42	1.60	1.79	1.68
Wyoming	1.35	1.60	1.08	1.55	1.65	1.96	1.47	1.68	1.76	1.65
Colorado	1.19	2.27	2.42	2.20	2.25	2.20	2.10	2.23	2.08	1.92
New Mexico	2.08	1.88	2.61	3.00	3.50	3.75	1.70	2.06	2.31	2.40
Arizona	1.75	1.82	1.85	3.20	3.00	3.50	2.63	2.31	2.85	2.34
Utah	1.72	2.52	2.56	2.70	2.95	3.25	2.50	2.65	2.45	2.62
Nevada	2.66	4.04	3.01	2.55	2.50	2.60	1.87	2.43	2.50	2.91
Idaho	2.45	2.53	2.57	2.60	2.30	3.75	2.50	2.80	2.58	2.67
Washington	1.58	2.05	1.85	1.95	2.25	1.75	2.02	2.16	2.30	2.29
Oregon	1.88	2.00	1.78	1.98	1.90	1.90	1.97	2.35	2.07	2.04
California	1.69	1.93	1.66	1.65	1.60	1.60	1.63	1.51	1.82	1.81
Oklahoma	......	......	......	......	......	......	......	......	.96	1.26
Indian Territory	......	......	......	......	......	......	......	......	1.46	1.32
General average	1.33	1.14	1.06	1.37	1.43	1.55	1.35	1.28	1.28	1.50

Average value per acre of hay in the United States, based upon farm value December 1, 1893–1902, by States.

States and Territories.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.
Maine	$11.16	$9.12	$9.87	$10.25	$10.73	$9.12	$9.09	$11.66	$10.96	$10.74
New Hampshire	16.54	9.97	11.88	12.38	13.23	11.56	10.46	13.48	15.87	14.36
Vermont	11.80	11.93	13.11	12.85	12.03	9.21	10.55	13.70	13.36	12.26
Massachusetts	19.93	19.53	19.42	20.99	19.46	17.18	17.52	16.88	21.16	26.64
Rhode Island	16.27	12.25	15.70	18.26	16.67	14.93	15.35	17.20	17.54	19.46
Connecticut	17.32	13.54	13.68	15.74	15.60	14.61	13.63	14.89	14.77	21.19
New York	14.05	11.30	10.00	9.75	11.14	8.05	10.87	11.38	13.75	14.11
New Jersey	17.26	16.34	15.29	16.50	18.81	13.63	12.74	20.22	18.86	19.08
Pennsylvania	14.83	13.35	12.42	12.88	12.81	11.46	13.80	15.29	15.90	16.66
Delaware	12.75	19.50	14.96	14.30	13.50	11.66	12.12	13.67	13.84	15.73
Maryland	14.82	11.46	14.44	10.31	14.17	11.16	13.73	15.31	16.07	14.19
Virginia	14.53	8.56	12.92	11.03	11.07	11.22	11.27	15.43	14.41	14.39
North Carolina	18.89	15.85	16.53	13.55	12.19	15.81	15.15	15.79	17.93	17.64
South Carolina	15.18	16.45	7.62	15.06	11.50	15.20	12.56	15.18	16.03	13.72
Georgia	15.92	14.36	17.44	15.25	17.55	20.56	19.07	21.55	20.92	18.22
Florida	39.50	19.99	20.24	18.20	14.25	22.56	22.41	16.44	22.72	19.02
Alabama	17.08	25.49	15.93	13.72	13.86	17.57	18.92	19.52	21.12	17.42
Mississippi	15.86	17.79	18.91	12.77	14.06	15.96	13.32	17.41	17.62	14.35
Louisiana	14.58	28.85	19.47	16.63	16.62	19.74	18.92	18.80	20.50	21.10
Texas	9.98	10.13	9.52	7.20	10.15	8.77	10.15	12.24	13.27	12.01
Arkansas	10.96	11.66	11.12	8.90	11.25	10.39	12.80	14.43	12.89	15.04
Tennessee	14.96	13.30	15.05	13.54	15.59	14.25	14.74	16.52	18.71	16.99
West Virginia	14.02	10.87	9.04	11.94	11.95	12.94	12.19	15.81	18.91	16.05
Kentucky	13.51	13.19	14.77	11.35	11.70	13.19	13.42	15.89	16.25	16.27
Ohio	13.37	10.74	7.40	9.99	9.00	7.99	11.63	11.71	11.86	14.59
Michigan	13.37	10.85	7.59	9.84	11.55	9.72	10.37	12.19	10.85	12.03
Indiana	12.46	9.63	7.34	9.33	8.44	8.12	10.45	11.80	11.79	12.66
Illinois	10.72	9.50	6.77	8.82	7.93	9.20	10.00	10.67	12.10	13.31
Wisconsin	10.94	10.42	8.47	8.25	8.44	8.62	10.07	11.10	13.58	15.03
Minnesota	7.40	5.41	6.66	6.41	7.06	6.66	7.40	8.06	8.65	9.43
Iowa	9.73	5.39	6.97	6.94	6.37	7.09	7.10	9.66	9.59	10.92
Missouri	8.73	6.65	7.96	6.94	7.07	9.28	8.56	8.97	8.99	10.96
Kansas	6.14	4.04	4.04	3.83	4.42	4.74	5.49	6.01	7.25	7.33
Nebraska	6.09	4.20	3.52	4.05	4.80	5.28	6.14	7.11	7.71	7.59
South Dakota	5.21	4.02	2.60	3.99	3.69	4.14	4.43	4.66	5.16	5.10
North Dakota	4.80	4.61	4.94	5.59	5.20	4.87	5.21	5.20	5.84	6.09
Montana	9.94	8.60	10.72	9.47	11.63	9.86	10.93	13.92	14.60	12.67

Average value per acre of hay in the United States, based upon farm value December 1, 1893–1902, by States—Continued.

States and Territories.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.
Wyoming	$10.89	$16.10	$7.02	$11.07	$9.90	$11.40	$9.70	$12.26	$12.64	$12.61
Colorado	8.31	17.12	14.21	13.68	12.38	11.88	15.43	16.95	18.89	[illegible]
New Mexico	17.68	21.62	20.88	17.10	21.59	27.56	18.02	20.39	[illegible]	[illegible]
Arizona	14.44	21.84	16.65	28.00	15.00	42.00	27.22	26.19	26.16	28.62
Utah	8.89	14.01	13.49	13.50	14.01	14.62	17.75	21.07	20.70	19.18
Nevada	26.60	29.29	20.32	12.29	12.50	18.20	14.31	18.71	19.80	29.73
Idaho	13.48	10.98	16.06	12.25	12.08	18.37	15.75	18.20	15.25	14.69
Washington	14.49	15.13	12.49	13.83	20.25	13.30	17.98	20.52	19.60	20.45
Oregon	15.23	11.72	10.89	13.07	14.73	13.78	13.49	15.98	14.82	15.26
California	13.30	18.34	11.72	10.48	14.40	22.80	13.04	12.31	14.41	17.03
Oklahoma	......	......	......	......	......	......	......	......	6.59	6.68
Indian Territory	......	......	......	......	......	......	......	......	11.01	6.57
General average	11.51	9.70	8.89	8.97	9.46	9.30	9.97	11.39	12.85	13.61

Average farm price of hay per ton in the United States, December 1, 1893–1902, by States.

States and Territories.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.
Maine	$12.13	$9.60	$9.68	$10.25	$9.75	$7.60	$10.10	$12.95	$10.44	$10.04
New Hampshire	15.60	10.50	12.50	12.90	11.50	9.25	11.75	15.50	12.40	13.55
Vermont	10.63	9.94	12.25	10.28	9.25	6.35	9.25	11.05	9.82	9.65
Massachusetts	17.33	15.50	17.50	16.40	13.90	12.10	15.50	17.40	17.49	16.65
Rhode Island	19.60	16.33	17.25	16.60	14.50	12.65	17.25	18.70	19.06	18.89
Connecticut	17.50	15.56	16.10	14.71	13.00	11.15	14.50	16.73	14.62	15.70
New York	11.33	9.66	13.70	12.04	8.25	5.75	10.45	14.05	10.58	10.53
New Jersey	17.43	14.09	12.64	14.35	10.75	9.60	15.35	16.05	14.29	15.64
Pennsylvania	14.40	11.31	12.30	12.15	9.15	7.90	11.50	13.90	13.64	14.00
Delaware	17.00	15.00	12.16	13.00	10.00	8.45	11.65	13.95	12.36	14.43
Maryland	14.25	11.13	11.55	11.85	10.50	9.30	12.15	14.05	13.17	14.05
Virginia	13.09	11.89	11.43	10.21	10.25	8.50	10.25	13.30	12.01	13.58
North Carolina	11.11	10.93	10.14	10.75	9.75	9.30	10.10	11.20	10.80	12.25
South Carolina	9.67	10.75	7.62	11.32	11.50	9.50	10.30	11.50	10.98	11.25
Georgia	12.06	12.38	10.90	11.05	13.00	11.75	13.15	12.75	14.33	13.40
Florida	19.75	16.25	13.23	13.00	14.25	14.10	15.35	13.70	15.35	15.34
Alabama	11.24	9.51	10.21	9.80	10.25	9.25	11.40	10.55	12.07	11.61
Mississippi	9.61	9.67	9.70	9.46	9.50	8.40	9.25	9.95	10.51	10.25
Louisiana	9.00	10.64	9.64	8.75	8.75	9.40	9.70	9.40	11.08	11.72
Texas	9.60	7.62	6.43	7.20	7.75	5.85	7.10	6.80	10.62	8.60
Arkansas	9.37	8.83	9.27	7.54	8.65	6.75	8.65	8.85	11.72	9.40
Tennessee	10.76	11.27	10.83	9.67	10.75	9.50	11.25	11.80	12.31	11.80
West Virginia	12.25	10.66	12.73	9.79	8.85	8.40	9.45	13.40	13.80	14.33
Kentucky	10.16	10.47	10.94	9.46	10.00	9.10	10.40	11.35	12.13	11.30
Ohio	10.05	8.46	12.76	7.93	6.25	5.75	8.95	11.05	8.72	10.20
Michigan	9.16	9.04	13.09	8.48	7.75	7.15	8.50	9.45	8.61	8.30
Indiana	9.16	7.58	12.03	7.18	5.90	5.60	7.80	9.75	9.28	8.67
Illinois	8.86	8.33	10.25	6.39	6.15	5.90	7.75	8.40	11.20	8.87
Wisconsin	7.20	7.96	9.63	6.60	6.25	5.75	6.85	9.65	10.53	7.91
Minnesota	4.57	5.30	5.12	3.79	4.50	3.70	4.35	6.95	5.58	5.36
Iowa	6.16	7.39	6.45	3.99	4.25	4.05	5.30	6.80	7.67	6.50
Missouri	7.04	7.82	6.80	4.85	6.15	5.80	6.25	6.95	11.99	6.89
Kansas	4.69	5.25	3.26	2.70	3.40	3.25	3.50	4.55	7.67	4.31
Nebraska	4.87	7.12	3.56	2.44	3.00	3.30	3.70	5.15	6.17	4.36
South Dakota	3.67	4.28	3.29	3.12	2.95	3.00	3.10	3.95	4.49	4.15
North Dakota	3.72	3.87	3.48	3.39	3.25	3.25	3.30	5.65	3.65	3.67
Montana	7.89	7.17	11.40	6.86	7.75	6.80	7.70	8.70	8.18	7.54
Wyoming	8.00	10.00	6.50	7.14	6.00	5.90	6.60	7.30	7.18	7.28
Colorado	6.98	7.54	5.87	6.22	5.50	5.40	7.35	7.60	9.04	9.89
New Mexico	8.50	11.50	8.00	5.70	7.00	7.35	10.60	9.90	10.34	11.18
Arizona	8.25	12.00	9.00	8.75	5.00	12.00	10.35	11.30	9.18	12.23
Utah	5.17	5.56	5.27	5.00	4.75	4.50	7.10	7.95	8.45	7.32
Nevada	10.00	7.25	6.75	4.82	5.00	7.00	7.65	7.70	7.92	9.05
Idaho	5.50	4.34	6.25	4.71	5.25	4.90	6.30	6.50	5.91	5.50
Washington	9.17	7.38	6.75	7.09	9.00	7.60	8.90	9.50	8.52	8.93
Oregon	8.10	5.86	6.12	6.60	7.75	7.25	6.85	6.80	7.16	7.48
California	7.87	9.50	7.06	6.35	9.00	14.25	8.00	8.15	7.92	9.41
Oklahoma	......	......	......	......	......	......	......	......	6.86	5.30
Indian Territory	......	......	......	......	......	......	......	......	7.54	4.98
General average	8.68	8.54	8.35	6.55	6.62	6.00	7.27	8.89	10.61	9.06

Wholesale prices of hay (baled) per ton in leading cities of the United States, 1898–1902.

Date.	New York. No. 1, per hundredweight.		Chicago. No. 1 Timothy, per ton.		Cincinnati. No. 1 Timothy, per ton.		St. Louis. No. 1 Timothy, per ton.	
	Low.	High.	Low.	High.	Low.	High.	Low.	High.
1898.								
January	\$0.72½	\$0.80	\$8.00	\$8.50	\$8.50	\$9.00	\$8.25	\$9.50
February	.72½	.75	8.00	8.50	8.00	9.00	8.50	9.50
March	.75	.80	9.00	9.50	8.00	9.00	9.00	10.00
April	.75	.80	8.50	9.00	8.50	10.00	9.00	12.50
May	.80	.80	9.50	10.50	9.00	10.25	10.50	12.00
June	.77½	.80	9.00	9.50	8.25	9.00	10.50	11.50
July	.77½	.77½	8.00	8.50	8.25	9.00	9.00	10.00
August	.70	.77½	8.00	8.50	7.50	9.00	7.00	10.00
September	.65	.70	7.50	8.00	7.50	8.00	7.00	8.00
October	.65	.67½	7.50	8.00	7.75	8.25	7.00	8.50
November	.65	.65	8.00	8.50	8.00	8.00	7.50	8.50
December	.65	.67½	8.00	8.25	8.00	8.25	7.50	8.50
1899.								
January	.65	.65	7.50	9.00	7.75	8.50	8.00	9.90
February	.65	.65	7.75	8.50	8.00	8.75	8.00	8.75
March	.65	.67½	8.50	10.00	9.00	11.00	8.00	10.00
April	.67½	.75	9.50	10.50	10.50	11.50	9.00	11.00
May	.75	.90	9.50	10.50	10.50	11.00	10.50	11.50
June	.80	.95	10.00	11.50	10.50	12.00	10.50	11.50
July	.85	.95	10.00	13.00	9.00	12.50	10.00	12.00
August	.87½	.95	9.00	13.00	9.00	10.50	8.00	12.00
September	.80	.90	9.50	11.50	9.00	11.25	8.00	10.50
October	.80	.92½	9.50	11.00	11.00	12.00	9.50	10.50
November	.80	.87½	10.50	11.50	11.50	13.00	10.00	10.75
December	.87½	.87½	10.50	11.50	12.00	13.00	10.00	11.50
1900.								
January	.87½	.87½	10.00	11.50	13.00	14.00	11.00	12.50
February	.87½	.87½	10.50	11.50	13.50	14.00	10.50	12.00
March	.87½	.90	10.50	11.50	13.75	14.25	11.00	12.50
April	.90	.90	10.50	14.00	14.50	15.00	11.50	13.00
May	.90	.95	10.50	12.50	14.25	15.00	11.00	13.50
June	.90	.92½	10.00	11.50	14.00	14.75	10.50	13.50
July	.90	.95	10.50	12.50	13.75	15.00	11.00	14.50
August	.90	.97½	11.00	12.50	11.50	15.00	9.75	13.00
September	.90	.95	11.00	12.00	12.50	13.75	10.00	12.00
October	.95	.95	11.00	12.00	13.50	14.50	11.00	12.50
November	.92½	.95	11.50	13.50	13.50	14.00	10.75	13.50
December	.90	.95	11.50	14.00	13.75	14.25	11.50	14.00
1901.								
January	.95	.95	11.50	14.00	14.00	14.50	11.50	13.50
February	.90	.97½	11.50	13.50	13.75	14.25	11.50	12.75
March	.92½	.97½	12.50	14.00	13.50	15.00	11.50	14.00
April	.95	.97½	12.50	14.00	13.75	15.00	12.50	14.50
May	.92½	1.00	12.00	13.50	13.75	14.25	12.00	14.50
June	.90	.92½	12.00	13.00	12.00	14.25	12.00	15.50
July	.87½	.95	12.00	15.00	11.50	15.50	12.50	17.50
August	.90	.95	12.00	15.00	11.75	14.50	13.00	16.00
September	.87½	.95	12.00	14.00	12.50	13.25	12.50	15.50
October	.92½	.92½	12.00	13.50	12.50	13.25	12.50	14.50
November	.90	.92½	12.00	13.50	12.50	13.25	13.00	14.50
December	.95	.95	12.50	13.90	13.00	14.00	13.50	15.00
1902.								
January	....	....	12.00	13.50	12.50	13.75	13.50	15.50
February	....	....	12.00	13.50	12.50	13.25	13.00	14.50
March	....	....	12.00	13.00	12.75	13.25	13.00	14.50
April	....	....	12.00	14.00	12.75	13.25	13.00	15.25
May	....	....	13.00	14.00	13.00	13.50	13.00	15.50
June	....	....	12.50	14.00	12.75	13.50	12.00	15.00
July	....	....	12.00	17.50	13.75	15.50	13.00	16.00
August	....	....	10.00	15.00	12.00	15.50	10.00	15.00
September	....	....	10.00	12.00	11.00	13.00	9.50	12.00
October	....	....	11.50	13.50	13.00	14.00	11.00	13.00
November	....	....	11.50	13.00	13.25	14.00	11.00	13.50
December	....	....	12.00	13.00	13.75	16.50	13.50	15.50

COTTON.

Condition of cotton crop in the United States, monthly, 1887–1902.

Year.	June.	July.	August.	September.	October.	Year.	June.	July.	August.	September.	October.
1887	96.9	96.9	93.3	82.8	76.5	1895	81.0	82.3	77.9	70.8	65.1
1888	88.2	86.7	87.3	83.8	78.9	1896	97.2	92.5	80.1	64.2	60.7
1889	86.4	87.6	89.3	86.6	81.5	1897	83.5	86.0	86.9	78.3	70.0
1890	88.8	91.4	89.5	85.5	80.0	1898	89.0	91.2	91.2	79.8	75.4
1891	85.7	88.6	88.9	82.7	75.7	1899	85.7	87.8	84.0	68.5	62.4
1892	85.9	86.9	82.3	76.8	73.3	1900	82.5	75.8	76.0	68.2	67.0
1893	85.6	82.7	80.4	73.4	70.7	1901	81.5	81.1	77.2	71.4	61.4
1894	88.3	89.6	91.8	85.9	82.7	1902	95.1	84.7	81.9	64.0	58.3

Acreage, production, value, prices, and exports of cotton of the United States, 1880–1901.

Year.	Acreage.	Average yield per acre.	Production.	Average farm price per pound, Dec. 1.	Value.	New York closing prices per pound on middling upland. December. Low.	December. High.	May of following year. Low.	May of following year. High.	Domestic exports fiscal years beginning July 1.
	Acres.	Bales.	Bales.	Cents.	Dollars.	Cts.	Cts.	Cts.	Cts.	Bales of 500 pounds.
1880	15,475,300	0.43	6,605,750	9.8	280,266,242	$11\frac{7}{8}$	12	$10\frac{7}{16}$	$10\frac{7}{8}$	4,381,857
1881	16,710,730	.33	5,456,048	10.0	294,135,547	$11\frac{7}{8}$	$12\frac{1}{8}$	$12\frac{1}{16}$	$12\frac{3}{8}$	3,479,952
1882	16,791,557	.41	6,949,756	9.9	309,696,500	$10\frac{1}{4}$	$10\frac{7}{16}$	$10\frac{1}{2}$	$11\frac{1}{8}$	4,576,150
1883	16,777,993	.34	5,713,200	9.0	250,594,750	$10\frac{3}{8}$	$10\frac{9}{16}$	$11\frac{1}{2}$	$11\frac{3}{4}$	3,725,145
1884	17,439,612	.33	5,706,165	9.2	253,993,385	$10\frac{7}{16}$	$11\frac{7}{16}$	$10\frac{11}{16}$	11	3,783,319
1885	18,300,865	.36	6,575,691	8.5	269,989,812	$9\frac{3}{16}$	$9\frac{7}{16}$	$9\frac{3}{16}$	$9\frac{5}{16}$	4,116,075
1886	18,454,603	.35	6,505,087	8.1	309,381,938	$9\frac{3}{16}$	$9\frac{9}{16}$	$10\frac{3}{4}$	$11\frac{7}{16}$	4,338,915
1887	18,641,067	.38	7,046,833	8.5	337,972,453	$10\frac{1}{2}$	$10\frac{5}{8}$	$9\frac{15}{16}$	$10\frac{1}{16}$	4,528,242
1888	19,058,591	.36	6,938,290	8.5	354,454,340	$9\frac{3}{4}$	$9\frac{7}{8}$	11	$11\frac{3}{16}$	4,769,633
1889	20,171,896	.36	7,311,322	8.3	402,951,814	$10\frac{1}{4}$	$10\frac{1}{4}$	$11\frac{15}{16}$	$12\frac{1}{4}$	4,943,600
1890	20,809,053	.42	8,652,597	8.6	369,568,858	$9\frac{3}{16}$	$9\frac{7}{16}$	$8\frac{7}{8}$	$8\frac{15}{16}$	5,814,717
1891	20,714,937	.44	9,035,379	7.3	326,513,298	$7\frac{3}{4}$	$8\frac{1}{16}$	$7\frac{1}{4}$	$7\frac{7}{16}$	5,870,440
1892	18,067,924	.37	6,700,365	8.4	262,252,286	$9\frac{3}{8}$	10	$7\frac{5}{8}$	$7\frac{13}{16}$	4,424,230
1893	19,525,000	.39	7,549,817	7.0	274,479,637	$7\frac{13}{16}$	$8\frac{1}{16}$	$7\frac{1}{8}$	$7\frac{3}{8}$	5,366,565
1894	23,687,950	.42	9,901,251	4.6	287,120,818	$5\frac{11}{16}$	$5\frac{13}{16}$	$6\frac{3}{4}$	$7\frac{3}{8}$	7,034,866
1895	20,184,808	.36	7,161,094	7.6	260,338,096	$8\frac{1}{4}$	$8\frac{9}{16}$	8	$8\frac{3}{8}$	4,670,453
1896	23,273,209	.37	8,532,705	6.6	291,811,564	$7\frac{1}{16}$	$7\frac{11}{16}$	$7\frac{5}{8}$	$7\frac{13}{16}$	6,207,510
1897	24,319,584	.45	10,897,857	6.6	319,491,412	$5\frac{13}{16}$	$5\frac{15}{16}$	$6\frac{5}{16}$	$6\frac{9}{16}$	7,725,572
1898	24,967,295	.45	11,189,205	5.7	305,467,041	$5\frac{5}{8}$	$5\frac{7}{8}$	$6\frac{1}{8}$	$6\frac{1}{4}$	7,575,838
1899	23,403,497	.39	9,142,838	7.0	334,847,868	$7\frac{9}{16}$	$7\frac{13}{16}$	$9\frac{5}{16}$	$9\frac{7}{8}$	6,201,166
1900			10,401,453		511,098,111	10	$10\frac{5}{16}$	$8\frac{1}{8}$	$8\frac{1}{4}$	6,661,751
1901			9,966,478							7,001,558

Statistics of the cotton-seed industry of the United States.

Year ended June 30—	Cotton-seed crop.	Percentage of crop manufactured.	Seed manufactured.	Oil produced.	Oil cake produced.[a]	Oil exported.	Oil retained for home consumption.
	Tons.	Per cent.	Tons.	Gallons.	Tons.	Gallons.	Gallons.
1872	1,317,637	4	52,705	2,108,000	18,400	547,165	1,560,835
1873	1,745,145	3	52,354	2,094,000	18,300	709,576	1,384,424
1874	1,851,652	4	74,066	2,963,000	25,900	782,067	2,180,933
1875	1,686,516	5	84,325	3,373,000	29,500	417,387	2,955,613
1876	2,056,746	6	123,404	4,936,000	43,200	281,054	4,654,946
1877	1,968,590	5	98,429	3,937,000	34,400	1,705,422	2,231,578
1878	2,148,239	7	150,376	6,015,000	52,600	4,992,349	1,022,656
1879	2,268,147	8	181,451	7,258,000	63,500	5,352,530	1,905,470
1880	2,615,608	9	235,404	9,416,000	82,400	6,997,796	2,418,204
1881	3,038,695	6	182,321	7,293,000	63,800	3,444,084	3,848,916
1882	2,455,221	12	294,626	11,785,000	103,100	713,549	11,071,451
1883	3,266,385	12	391,966	15,679,000	137,200	415,611	15,263,389
1884	2,639,498	15	395,924	15,837,000	138,500	3,605,946	12,231,054
1885	2,624,835	19	498,718	19,949,000	174,500	6,364,279	13,584,721

[a] Exports of oil cake since 1895 have been as follows (in tons of 2,000 pounds): 1895, 244,858 tons; 1896, 202,468 tons; 1897, 311,693 tons; 1898, 459,863 tons; 1899, 539,996 tons; 1900, 571,852 tons; 1901, 629,343 tons; 1902, 525,233 tons.

Statistics of the cotton-seed industry of the United States—Continued.

Year ended June 30—	Cotton-seed crop.	Percentage of crop manufactured.	Seed manufactured.	Oil produced.	Oil cake produced.	Oil exported.	Oil retained for home consumption.
	Tons.	*Per cent.*	*Tons.*	*Gallons.*	*Tons.*	*Gallons.*	*Gallons.*
1886	3,044,544	19	578,463	23,138,000	202,400	6,240,139	16,897,861
1887	3,018,360	23	694,222	27,769,000	243,000	4,067,138	23,701,862
1888	3,290,871	25	822,717	32,909,000	287,900	4,458,597	28,450,403
1889	3,309,564	24	794,295	31,772,000	278,000	2,690,700	29,081,300
1890	3,494,811	25	873,702	34,948,000	305,800	13,384,385	21,563,615
1891	4,092,678	25	1,023,169	40,927,000	358,100	11,003,160	29,923,840
1892	4,273,734	25	1,068,433	42,737,000	374,000	13,859,278	28,877,722
1893	3,182,673	33	1,050,282	42,011,000	367,600	9,462,074	32,548,926
1894	3,578,613	40	1,431,445	57,258,000	501,000	14,958,309	42,299,691
1895	4,792,205	35	1,677,271	67,090,840	587,044	21,187,728	45,903,112
1896	3,415,842	42	1,434,653	57,386,120	502,128	19,445,848	37,940,272
1897	4,070,100	40	1,628,040	65,122,000	569,800	27,198,882	37,923,118
1898	5,252,767	40	2,101,106	84,044,000	735,300	40,230,784	43,813,216
1899	5,471,521	43	2,352,754	94,110,000	823,400	50,627,219	43,482,781
1900	4,668,346	53	2,479,386	93,325,729	884,391	46,902,390	46,423,339
1901	4,830,280	50	2,415,140	96,605,600	845,299	49,356,741	47,248,859
1902	4,983,239	60	2,975,000	119,000,000	1,041,250	33,042,848	85,957,152

Food constituents of cotton-seed meal.

	Fresh, or air-dry, material.					
	Water.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Minimum	5.29	1.72	23.27	1.88	9.13	2.18
Maximum	18.52	10.62	52.88	15.15	38.68	20.66
Average	8.52	7.02	43.26	5.44	22.31	13.45

Prices of middling upland cotton in New Orleans, 1890–1902.

[In cents per pound.]

Year.	January.		February.		March.		April.		May.		June.	
	Low.	High.	Low.	High.	Low.	High.	Low.	High.	Low.	High.	Low.	High.
1890	$9\frac{5}{8}$	$10\frac{11}{16}$	$10\frac{3}{8}$	$10\frac{11}{16}$	$10\frac{11}{16}$	11	11	$11\frac{11}{16}$	$11\frac{9}{16}$	$11\frac{7}{8}$	$11\frac{7}{16}$	$11\frac{7}{8}$
1891	$8\frac{15}{16}$	$9\frac{5}{16}$	$8\frac{3}{4}$	$9\frac{1}{16}$	$8\frac{5}{8}$	$8\frac{3}{4}$	$8\frac{5}{16}$	$8\frac{11}{16}$	$8\frac{5}{16}$	$8\frac{3}{8}$	$7\frac{7}{8}$	$8\frac{1}{4}$
1892	$6\frac{13}{16}$	$7\frac{3}{16}$	$6\frac{1}{2}$	$6\frac{7}{8}$	$6\frac{1}{4}$	$6\frac{1}{2}$	$6\frac{3}{8}$	7	7	$7\frac{3}{16}$	$7\frac{1}{16}$	$7\frac{1}{2}$
1893	$9\frac{1}{4}$	$9\frac{5}{8}$	$8\frac{13}{16}$	$9\frac{1}{4}$	$8\frac{5}{16}$	9	$7\frac{7}{16}$	$8\frac{3}{16}$	$7\frac{1}{4}$	$7\frac{5}{8}$	$7\frac{5}{16}$	$7\frac{7}{8}$
1894	$7\frac{5}{16}$	$7\frac{3}{4}$	$7\frac{1}{16}$	$7\frac{7}{16}$	$7\frac{1}{8}$	$7\frac{5}{16}$	7	$7\frac{5}{16}$	$6\frac{13}{16}$	$7\frac{1}{16}$	$6\frac{7}{8}$	$7\frac{1}{8}$
1895	5	$5\frac{3}{16}$	5	$5\frac{3}{16}$	$5\frac{1}{16}$	$5\frac{7}{8}$	$5\frac{3}{4}$	$6\frac{3}{8}$	$6\frac{3}{16}$	7	$6\frac{5}{8}$	7
1896	$7\frac{13}{16}$	8	$7\frac{1}{2}$	8	$7\frac{3}{8}$	$7\frac{13}{16}$	$7\frac{5}{8}$	$7\frac{3}{4}$	$7\frac{3}{8}$	$7\frac{3}{4}$	$6\frac{13}{16}$	$7\frac{3}{8}$
1897	$6\frac{7}{8}$	7	$6\frac{11}{16}$	$7\frac{3}{16}$	$6\frac{15}{16}$	$7\frac{3}{16}$	$6\frac{15}{16}$	$7\frac{9}{16}$	$7\frac{5}{16}$	$7\frac{9}{16}$	$7\frac{3}{8}$	$7\frac{5}{8}$
1898	$5\frac{3}{16}$	$5\frac{3}{8}$	$5\frac{1}{4}$	$5\frac{11}{16}$	$5\frac{7}{16}$	$5\frac{3}{4}$	$5\frac{9}{16}$	$5\frac{3}{4}$	$5\frac{11}{16}$	$6\frac{1}{16}$	$5\frac{7}{8}$	$6\frac{1}{16}$
1899	$5\frac{3}{16}$	$5\frac{3}{4}$	$5\frac{3}{4}$	6	$5\frac{11}{16}$	$6\frac{1}{16}$	$5\frac{5}{8}$	$5\frac{3}{4}$	$5\frac{11}{16}$	$5\frac{7}{8}$	$5\frac{1}{2}$	$5\frac{3}{4}$
1900	$7\frac{1}{4}$	$7\frac{3}{4}$	$7\frac{7}{8}$	9	9	$9\frac{7}{16}$	$9\frac{1}{8}$	$9\frac{1}{2}$	$8\frac{13}{16}$	$9\frac{1}{2}$	$8\frac{13}{16}$	$9\frac{13}{16}$
1901	$9\frac{5}{16}$	$9\frac{11}{16}$	$9\frac{1}{16}$	$9\frac{5}{16}$	$7\frac{15}{16}$	$9\frac{1}{16}$	8	$8\frac{5}{16}$	$7\frac{9}{16}$	8	$7\frac{3}{4}$	$8\frac{7}{16}$
1902	$7\frac{3}{4}$	8	$7\frac{13}{16}$	$8\frac{3}{16}$	$8\frac{1}{4}$	$8\frac{5}{8}$	$8\frac{9}{16}$	$9\frac{3}{4}$	$9\frac{1}{8}$	$9\frac{3}{4}$	$8\frac{15}{16}$	$9\frac{5}{16}$

Year.	July.		August.		September.		October.		November.		December.	
	Low.	High.	Low.	High.	Low.	High.	Low.	High.	Low.	High.	Low.	High.
1890	$11\frac{7}{16}$	$11\frac{3}{4}$	$10\frac{3}{8}$	$11\frac{3}{4}$	$9\frac{3}{4}$	$10\frac{1}{4}$	$9\frac{11}{16}$	$10\frac{1}{16}$	$9\frac{1}{16}$	$9\frac{3}{16}$	$8\frac{13}{16}$	$9\frac{1}{8}$
1891	$7\frac{3}{4}$	$7\frac{15}{16}$	$7\frac{5}{8}$	8	8	$8\frac{1}{8}$	$7\frac{15}{16}$	$8\frac{3}{8}$	$7\frac{3}{8}$	$7\frac{7}{8}$	7	$7\frac{1}{8}$
1892	7	$7\frac{3}{16}$	$6\frac{15}{16}$	$7\frac{3}{16}$	$6\frac{15}{16}$	$7\frac{7}{16}$	$7\frac{7}{16}$	$7\frac{13}{16}$	$7\frac{11}{16}$	$9\frac{7}{8}$	$9\frac{5}{16}$	$9\frac{11}{16}$
1893	$7\frac{7}{16}$	$7\frac{3}{4}$	$6\frac{13}{16}$	$7\frac{5}{8}$	$7\frac{5}{16}$	$8\frac{3}{16}$	$7\frac{5}{8}$	$8\frac{1}{8}$	$7\frac{7}{16}$	$7\frac{3}{4}$	$7\frac{1}{8}$	$7\frac{9}{16}$
1894	$6\frac{5}{8}$	$6\frac{7}{8}$	$6\frac{7}{16}$	$6\frac{5}{8}$	$5\frac{11}{16}$	$6\frac{1}{8}$	$5\frac{3}{16}$	$5\frac{3}{4}$	$4\frac{7}{8}$	$5\frac{1}{2}$	$5\frac{1}{16}$	$5\frac{5}{16}$
1895	$6\frac{1}{2}$	$6\frac{3}{4}$	$6\frac{9}{16}$	$7\frac{11}{16}$	$7\frac{9}{16}$	$8\frac{3}{4}$	$8\frac{5}{16}$	$9\frac{3}{16}$	$8\frac{1}{16}$	$8\frac{5}{8}$	$7\frac{3}{4}$	$8\frac{3}{16}$
1896	$6\frac{1}{2}$	$6\frac{13}{16}$	$6\frac{13}{16}$	8	$7\frac{5}{8}$	$8\frac{1}{8}$	$7\frac{1}{8}$	$7\frac{5}{8}$	$7\frac{3}{16}$	$7\frac{1}{2}$	$6\frac{11}{16}$	$7\frac{3}{8}$
1897	$7\frac{11}{16}$	$7\frac{13}{16}$	$7\frac{1}{16}$	$7\frac{11}{16}$	$6\frac{1}{16}$	$7\frac{1}{16}$	$5\frac{1}{2}$	$6\frac{1}{8}$	$5\frac{1}{4}$	$5\frac{1}{2}$	$5\frac{1}{4}$	$5\frac{5}{8}$
1898	$5\frac{5}{8}$	$5\frac{7}{8}$	$5\frac{1}{8}$	$5\frac{11}{16}$	$4\frac{7}{8}$	$5\frac{3}{8}$	$4\frac{13}{16}$	5	$4\frac{3}{4}$	$5\frac{1}{16}$	5	$5\frac{1}{4}$
1899	$5\frac{5}{8}$	$5\frac{3}{4}$	$5\frac{3}{4}$	$5\frac{15}{16}$	$5\frac{3}{4}$	$6\frac{1}{2}$	$6\frac{3}{4}$	$6\frac{15}{16}$	$6\frac{7}{8}$	$7\frac{7}{16}$	$7\frac{3}{16}$	$7\frac{1}{2}$
1900	$9\frac{7}{8}$	$10\frac{1}{4}$	$9\frac{3}{8}$	$10\frac{1}{4}$	$9\frac{3}{8}$	$11\frac{1}{8}$	$8\frac{13}{16}$	$10\frac{5}{16}$	9	$9\frac{7}{8}$	$9\frac{1}{4}$	$9\frac{13}{16}$
1901	$8\frac{1}{8}$	$8\frac{7}{16}$	8	$8\frac{15}{16}$	$7\frac{15}{16}$	$8\frac{5}{8}$	$7\frac{7}{16}$	$8\frac{5}{16}$	$7\frac{1}{4}$	$7\frac{7}{16}$	$7\frac{3}{4}$	$8\frac{1}{16}$
1902	$8\frac{5}{8}$	$9\frac{1}{16}$	$8\frac{3}{8}$	$8\frac{5}{8}$	$8\frac{3}{16}$	$8\frac{5}{8}$	8	$8\frac{1}{2}$	$7\frac{5}{8}$	8	$7\frac{15}{16}$	$8\frac{3}{8}$

Closing prices upland middling cotton per pound, in leading cities of the United States, 1897–1902.

Date.	New York.		New Orleans.		Memphis.		Galveston.		Savannah.		Charleston.		Wilmington.		Norfolk.	
	Low.	High.	Low.	High.	Low.	High.	Low.	High.	Low.	High.	Low.	High.	Low.	High.	Low.	High.
1897.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	7 1/16	7 5/16	6 7/8	7	6 3/4	6 15/16	6 13/16	7	6 9/16	6 7/8	6 9/16	7	6 5/8	6 7/8	6 3/4	6 15/16
February	7	7 7/16	6 11/16	7 3/16	6 3/4	7	6 3/4	7 1/8	6 5/8	7	6 1/2	7	6 3/4	6 7/8	6 13/16	7 1/16
March	7 3/16	7 7/16	6 15/16	7 3/16	6 7/8	7 1/16	7	7 1/4	6 3/4	7	6 7/8	7	6 7/8	7	7	7 3/16
April	7 5/16	7 3/4	6 15/16	7 9/16	6 15/16	7 3/8	7	7 1/2	6 7/8	7 3/8	6 15/16	7 3/8	7	7 3/8	7 3/16	7 7/16
May	7 5/8	7 13/16	7 3/8	7 9/16	7 1/4	7 3/8	7 1/4	7 1/2	7 3/8	7 1/2	7 1/4	7 3/8	7 3/8	7 1/2	7 1/2	7 5/8
June	7 11/16	7 7/8	7 3/8	7 5/8	7 3/16	7 1/2	7 1/4	7 5/8	7 1/4	7 1/2	7 1/4	7 1/2	7 1/2	7 5/8	7 1/8	7 3/4
July	7 7/8	8	7 5/8	7 13/16	7 1/2	7 13/16	7 5/8	7 11/16	7 1/2	7 3/4	7 1/2	7 3/4	7 5/8	8 1/8	7 3/4	8 1/8
August	7 7/8	8 1/4	7 1/16	7 11/16	7 7/16	7 13/16	7 1/8	7 5/8	7	7 3/4	7	7 3/4	7	8 1/8	8	8 1/8
September	6 1/2	7 13/16	6 1/16	7 1/16	6	7 7/16	6 1/4	7 1/8	5 13/16	7	5 13/16	7	6	7	6 3/16	[illegible]
October	6	6 1/2	5 1/2	6 1/8	5 1/2	6 1/16	5 11/16	6 3/8	5 3/8	5 15/16	5 3/8	6	5 1/2	6 1/2	5 9/16	6 1/4
November	5 13/16	6	5 1/4	5 1/2	5 1/4	5 7/8	5 3/8	5 5/8	5 1/2	5 5/16	5 1/8	5 5/16	5 3/16	5 1/2	5 5/8	5 9/16
December	5 13/16	5 15/16	5 1/4	5 3/8	5 1/4	5 5/16	5 3/8	5 1/2	5 1/8	5 3/16	5 3/16	5 3/16	5	5 1/2	5 1/2	5 1/2
1898.																
January	5 7/8	5 15/16	5 3/16	5 3/8	5 5/16	5 3/8	5 7/16	5 9/16	5 1/8	5 1/4	5 3/16	5 5/16	5 3/8	5 7/16	5 7/16	5 1/2
February	5 15/16	6 5/16	5 1/4	5 11/16	5 5/16	5 3/4	5 1/2	6	5 3/16	5 15/16	5 1/4	5 3/4	5 3/8	5 3/4	5 1/2	5 15/16
March	6 1/16	6 5/16	5 7/16	5 3/4	5 1/2	5 13/16	5 5/8	6 1/16	5 9/16	5 3/4	5 1/2	5 3/4	5 3/4	6	5 3/4	6
April	6 3/16	6 7/8	5 9/16	5 13/16	5 1/2	6	5 3/4	5 7/8	5 9/16	5 7/8	5 9/16	5 13/16	5 5/8	6 1/4	5 13/16	6 3/16
May	6 5/16	6 9/16	5 11/16	6 1/16	5 3/4	6	5 11/16	6	5 11/16	6	5 3/4	5 3/4	6	6 1/4	6 1/8	6 3/8
June	6 5/16	6 9/16	5 15/16	6 1/16	5 7/8	6	6 13/16	6	5 3/4	6	6	6	5 7/8	6 1/8	6 3/16	6 3/8
July	6 1/16	6 1/4	5 3/8	5 15/16	5 3/4	5 7/8	5 11/16	5 13/16	5 5/8	5 3/4	5 1/2	5 1/2	5 5/8	5 3/8	5 7/8	6 1/4
August	5 3/4	6 1/8	5 5/8	5 11/16	5 3/8	5 3/4	5 7/16	5 11/16	5 1/8	5 11/16	5	5 1/2	5 1/4	5 3/8	5 5/8	[illegible]
September	5 5/16	5 13/16	4 7/8	5 3/8	4 7/8	5 5/16	4 7/8	5 7/16	4 3/4	5 3/16	4 3/4	5 1/8	4 7/8	5 1/4	5 1/8	5 5/8
October	5 5/16	5 1/2	4 7/8	5 1/4	4 7/8	5	4 7/8	6 1/16	4 5/8	4 13/16	4 11/16	4 7/8	4 7/8	5	5	5 1/2
November	5 5/16	5 3/4	4 3/4	5 1/16	4 7/8	5 3/16	4 7/8	5 1/4	4 1/2	4 7/8	4 9/16	4 15/16	4 3/4	5	4 15/16	5 1/4
December	5 5/8	5 7/8	5	5 1/4	5 1/4	5 3/8	5 1/4	5 1/2	4 7/8	5 1/8	4 15/16	5 1/4	5	5 3/8	5 1/4	5 7/16
1899.																
January	5 7/8	6 7/16	5 3/16	5 3/4	5 3/8	5 3/4	5 7/16	6 1/16	5 1/16	5 3/4	5 1/8	5 3/4	5 3/8	5 7/8	5 3/8	6
February	6 5/16	6 5/8	5 11/16	6	5 11/16	6 1/8	6	6 3/8	5 5/8	5 15/16	5 11/16	5 15/16	5 5/8	6	6	6 1/4
March	6 3/16	6 9/16	5 11/16	6 1/8	5 7/8	6 1/8	5 15/16	6 1/4	5 11/16	5 7/8	5 5/8	5 15/16	6	6	6	6 1/8
April	6 1/8	6 5/16	5 5/8	5 3/4	5 3/4	5 7/8	5 7/8	5 15/16	5 5/8	5 11/16	5 1/2	5 5/8	5 7/8	6	5 7/8	6
May	6 1/8	6 1/4	5 11/16	5 7/8	5 3/4	5 3/4	5 7/8	5 15/16	5 5/8	5 5/8	5 1/2	5 9/16	5 7/8	5 7/8	5 7/8	6
June	6 1/16	6 5/16	5 1/2	5 3/4	5 5/8	5 13/16	5 3/4	5 15/16	5 5/8	5 5/8	6 3/16	6 3/8	5 7/8	5 7/8	5 7/8	6 1/8
July	6 1/8	6 1/4	5 5/8	5 3/4	5 5/8	5 3/4	5 7/8	5 7/8	5 5/8	5 5/8	....	....	5 7/8	5 7/8	5 7/8	6
August	6 1/8	6 1/2	5 3/4	5 15/16	5 3/4	5 15/16	5 7/8	6 1/8	5 1/2	5 7/8	5 1/2	5 11/16	5 7/8	[illegible]	5 13/16	6 1/8
September	6 1/4	6 7/8	5 3/4	6 1/2	5 7/8	6 3/4	6 1/16	6 3/8	5 5/8	6 1/2	5 5/8	6 3/8	5 7/8	6 1/2	6	6 1/4
October	7 3/4	7 1/8	6 1/2	6 15/16	6 3/4	7 1/8	6 1/16	7 1/8	6 5/8	6 5/8	6 5/8	7	6 1/2	7 1/4	7 1/16	7 1/16
November	7 3/8	7 13/16	6 7/8	7 7/16	7	7 1/2	7 1/16	7 1/2	6 7/8	7 1/4	6 1/8	7 3/8	7 1/8	7 1/2	7 1/16	7 1/8
December	7 1/2	7 1/4	7 3/16	7 1/8	7 1/4	7 7/16	7 1/4	7 7/16	7 1/8	7 5/16	7 3/16	7 3/8	7	7 1/4	7 5/16	7 1/8

Closing prices upland middling cotton per pound, in leading cities of the United States, 1897–1902—Continued.

Date.	New York.		New Orleans.		Memphis.		Galveston.		Savannah.		Charleston.		Wilmington.		Norfolk.	
	Low.	High.	Low.	High.	Low.	High.	Low.	High.	Low.	High.	Low.	High.	Low.	High.	Low.	High.
1900.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	7¼	8	7¼	7¾	7⅜	7 11/16	7¼	7 11/16	7 5/16	7⅝	7¼	7⅝	7¼	7½	7 7/16	7⅞
February	8⅛	9 5/16	7⅞	8⅞	7 11/16	8¾	7¾	8 13/16	7 11/16	8 15/16	7⅝	8¾	7⅛	8¾	7⅞	9⅛
March	9 7/16	9⅞	9	9 7/16	8⅞	9 7/16	9⅛	9⅝	9 1/16	9½	9	9½	9	9½	9¼	9⅞
April	9 9/16	9⅞	9⅛	9½	9¼	9⅜	9¼	9 7/16	9⅜	9 7/16	9¼	9⅜	9¼	9½	9½	9⅝
May	9	9⅞	8 13/16	9½	8¾	9 7/16	8⅞	9 7/16	9	9 7/16	9 5/16	9⅜	9¼	9¼	9¼	9⅝
June	8¾	9⅝	8 13/16	10	8⅝	9⅝	8½	9⅜	8¾	9¼	....	....	....	....	8¾	9⅝
July	9 13/16	10¼	9⅞	10¼	9⅝	10	9⅜	9½	9 5/16	9⅞	9½	9⅝	....	....	9¾	10 1/16
August	9½	10¼	9½	10¼	9½	9¾	8⅞	9 9/16	9	9¾	8⅝	9½	....	....	9¼	10
September	9⅝	11	9½	11⅛	9 5/16	11	9¼	10	9 1/16	10¾	8⅞	10¾	9	10¾	9⅜	11
October	9½	11	8 13/16	10¼	8⅞	10 3/16	8⅞	10	8 13/16	10 1/16	8¾	10	9	10¼	9	10 5/16
November	9 9/16	10¼	9	9⅞	8 15/16	10	9	9¾	8 15/16	9¾	9	9 11/16	9	9⅝	9	9 13/16
December	9¾	10 5/16	9¼	9 13/16	9⅜	9 13/16	9¼	9 11/16	9 1/16	9 11/16	9	9⅝	9¼	9⅝	9¼	9¾
1901.																
January	9⅞	12	9 5/16	9 11/16	9	9⅝	9⅜	9 11/16	9⅜	9⅝	9¼	9⅝	9¼	9½	9⅜	9 11/16
February	9 1/16	10	9 1/16	9 5/16	9 1/16	9 7/16	9⅛	9 7/16	9	9⅜	9	9⅞	9	9½	9⅛	9 7/16
March	8⅛	9 15/16	7 15/16	9 1/16	8	9⅛	8	9⅛	7⅞	9	7¾	9	7⅞	9	8	9¼
April	8¼	8 9/16	8 1/16	8 5/16	8	8¼	8⅛	8⅜	7 15/16	8⅛	7⅞	8	7½	7⅞	8 1/16	8¼
May	8 1/16	8 5/16	7 9/16	8	7 9/16	8	7⅝	8¼	7 7/16	8 1/16	7½	8	7¾	7⅞	7⅝	8 1/16
June	8¼	8 15/16	7¾	8⅜	7⅝	8 5/16	7 13/16	8 7/16	7½	8⅛	7⅛	8¾	7¾	7¾	7¾	8 7/16
July	8⅛	8⅞	8⅛	8 7/16	8	8 5/16	8⅛	8½	8	8¼	8⅛	8¼	7¾	8¼	7¾	8½
August	8	8⅝	8	8 15/16	8	8⅝	8 1/16	8 15/16	7⅝	8⅜	7¾	8¼	8	8¼	7 13/16	8⅝
September	8 3/16	8⅝	7 15/16	8⅝	7 13/16	8⅝	7 15/16	8 15/16	7⅝	8⅜	7⅝	8⅜	8	8¼	8	8⅝
October	7	8 9/16	7 7/16	8 5/16	7½	8⅝	7⅝	8⅜	7 3/16	8	7 3/16	8⅛	7⅜	8⅜	7⅜	8 3/16
November	7 13/16	8	7¼	7 7/16	7⅛	7⅝	7⅜	7⅝	7⅛	7 5/16	7⅛	7⅜	7⅛	7⅜	7¼	7½
December	8	8¾	7⅜	8 7/16	7 5/16	8	7½	8⅛	7¼	7 15/16	7 11/16	8	7½	7⅞	7½	8 1/16
1902.																
January	8 3/16	8 9/16	7¾	8	7	7 15/16	7⅞	8	7¾	7⅞	7 3/16	7⅞	7¾	7⅞	7 13/16	8
February	8¼	8 13/16	7 13/16	8 3/16	7 13/16	8¼	7 15/16	8 5/16	7 13/16	8 5/16	7⅞	8 5/16	7⅞	8¼	7 15/16	8½
March	8⅞	9 3/16	8¼	8⅝	8¼	8⅝	8 7/16	8⅝	8 5/16	8⅝	8¼	8⅝	8¼	8⅝	8½	8 13/16
April	9	9⅞	8 9/16	9¾	8½	9½	8⅝	9⅝	8 9/16	9 9/16	8 3/16	9⅜	8⅝	9⅜	8¾	9¾
May	9⅛	9¾	9⅛	9¾	9	9½	9 3/16	9⅝	9 3/16	9½	9¼	9⅜	9	9½	9¼	9¾
June	9¼	9 7/16	8 15/16	9 5/16	8 13/16	9 1/16	8 15/16	9¼	9	9 3/16	8¾	8¾	9	9⅛	9⅛	9¼
July	8 15/16	9⅜	8⅝	9 1/16	8 13/16	9	8¾	8 15/16	8¾	8⅞	8⅝	8⅝	8¾	9	9	9⅛
August	8⅞	9	8 5/16	8⅝	8½	8 13/16	8 7/16	8¾	8⅛	8¾	8 3/16	8¼	8½	8¾	8¾	9 1/16
September	8⅞	9⅛	8 3/16	8⅝	8¼	8 7/16	8¼	8⅝	8⅜	8 9/16	8⅛	8⅜	8⅜	8½	8½	9
October	8 9/16	8 15/16	8	8½	7 15/16	8 7/16	8 3/16	8 9/16	7⅞	8¼	7⅞	8¼	8⅛	8⅜	8½	8 9/16
November	8 5/16	8⅝	7⅝	8	7⅜	8	7¾	8 3/16	7 9/16	7 15/16	7 9/16	8	7¾	8⅛	7¾	8 3/16
December	8½	8⅞	7 15/16	8⅜	8	8 5/16	8⅛	8½	7⅞	8¼	7⅞	8¼	7¾	8⅛	8 1/16	8½

TOBACCO.

Acreage, production, and value of tobacco in the United States in 1902.

State.	Tobacco.				
	Acreage.	Yield per acre.	Production.	Price per pound.	Total value.
	Acres.	*Pounds.*	*Pounds.*	*Cents.*	*Dollars.*
New Hampshire	131	1,650	216,150	16	34,584
Vermont	191	1,800	343,800	14	48,132
Massachusetts	4,755	1,560	7,417,800	15	1,112,670
Connecticut	12,725	1,712	21,785,200	16	3,485,632
New York	8,040	1,250	10,050,000	8	804,000
Pennsylvania	17,269	1,275	22,017,975	6	1,321,078
Maryland	34,081	625	21,300,625	6	1,278,038
Virginia	182,359	750	136,769,250	7	9,573,848
North Carolina	219,263	650	142,520,950	7	9,976,466
South Carolina	34,912	734	25,625,408	7	1,793,779
Georgia	2,050	670	1,373,500	19	260,965
Florida	3,079	520	1,601,080	30	480,324
Alabama	648	400	259,200	24	62,208
Mississippi	175	500	87,500	18	15,750
Louisiana	89	375	33,375	20	6,675
Texas	269	650	174,850	22	38,467
Arkansas	1,405	640	899,200	12	107,904
Tennessee	59,830	650	38,889,500	6	2,333,370
West Virginia	4,676	635	2,969,260	7	207,848
Kentucky	322,194	800	257,755,200	6	15,465,312
Ohio	62,949	885	55,709,865	7	3,899,691
Michigan	302	765	231,030	8	18,482
Indiana	7,469	835	6,236,615	7	436,563
Illinois	1,311	650	852,150	7	59,650
Wisconsin	48,422	1,340	64,885,480	7	4,541,984
Missouri	2,140	850	1,819,000	11	200,090
United States	1,030,734	797.3	821,823,963	7.0	57,563,510

HOPS.

Wholesale prices of hops per pound in leading cities of the United States, 1898–1902.

Date.	New York.		Cincinnati.		Chicago.	
	Choice State.		Choice.		Pacific coast, common to choice.	
	Low.	High.	Low.	High.	Low.	High.
1898.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	18	19	16	16	10	17
February	18	19	16	16	10	17
March	17	18	16	16	10	17
April	15	17	15	15	10	16
May	12	15	16	16	10	14
June	12	13	15	15½	10	13
July	11	12	14	15	8	10
August	11	12	14	14	5	10
September	11	15	14	14	5	10
October	15	19	14	19	16	18
November	18	20	20	20	15	19½
December	18	20	19	19	16	19
1899.						
January	18	18	19	19	15	18
February	18	18	18	19	12	18
March	17	18	18	19	13	18
April	15	17	18	18½	13	18
May	16	16	16½	18	12	18
June	15	16	16	18	12	18
July	15	16	16	18	12	18
August	14	15	16	17	12	18
September	12	13	16	16	12½	16
October	13	15	13	13	9	16
November	13	14	13½	13½	9	13
December	12½	14	13	13	7	13

Wholesale prices of hops per pound in leading cities of the United States, 1898–1902—Cont'd.

Date.	New York.		Cincinnati.		Chicago.	
	Choice State.		Choice.		Pacific coast, common to choice.	
	Low.	High.	Low.	High.	Low.	High.
1900.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	12½	13½	13	13	9	10
February	12½	13½	13	13	9	10
March	12½	13½	12½	12½	9	10
April	12½	13½	12½	12½	9	10
May	12½	14	10	10	10	11
June	13	14	10	10	6½	10
July	13	14	10	10	6½	11
August	13	15	10	10	6¾	11
September	13	15	16½	16½	8	11
October	17	21	16½	16½	17	18
November	20	21	17½	17½	17	18
December	18	21	18	18	17	18
1901.						
January	17	20	17$\frac{4}{5}$	17$\frac{4}{5}$	17	18
February	....	....	17$\frac{7}{10}$	17$\frac{7}{10}$	17	18
March	18	20	17$\frac{4}{5}$	17$\frac{4}{5}$	18	19
April	18	20	17$\frac{4}{5}$	17$\frac{4}{5}$	18	19
May	17½	20	17$\frac{9}{10}$	17$\frac{9}{10}$	18	19
June	17½	18	17$\frac{4}{5}$	17$\frac{4}{5}$	17	18
July	16	18	17$\frac{9}{10}$	17$\frac{9}{10}$	17	18
August	14	17	17$\frac{7}{20}$	17$\frac{7}{20}$	15	16
September	13	16	14¼	14¼	14	15
October	14	15½	14	14	12½	14
November	14	15½	13¾	13¾	12½	14
December	14	15½	13$\frac{19}{20}$	13$\frac{19}{20}$	13	15
1902.						
January	14	16	14½	14½	12½	14
February	14½	18	15½	15½	15	16
March	17	19	17½	17½	13	16½
April	18	20	18½	18½	15	18
May	19	22	19½	19½	15	20
June	20½	24	21½	21½	15	20
July	22	26	23	23	20	22
August	24½	28	25	25	22	25
September	26	28	26½	26½	25	26
October	32	37	29½	29½	26	29
November	35	38	30	30	26	30
December	35	38	30	30	29	31

Expenses and Returns of Hop Raising.

Hop pickers in California get from 60 cents to $1.10 per hundred pounds of green hops, the average being about 75 cents. The pay of good hop driers is $2.50 to $5 per day and board. That of helpers, where they assist in taking off and putting on the hops in the night, is $1.25 per day and board. Field foremen get $1.50 to $2 per day and board. When contracts are made for growing hops (hand work alone) ready for picking, the price is $10 to $12 per acre. When the contract is for all work, including use of team in cultivating, the price is $14 or $15 per acre, owner to furnish teams and tools and make repairs, and the money to be advanced in equal monthly payments from February 1 to September 1.

The usual weight for a bale of hops is 190 to 200 pounds. When sales are made a deduction of 5 pounds from each bale is made for "tare." Sales are usually made by sample. The price of hops on the Pacific coast has ranged all the way from 5 cents to $1.10 per pound, which amply illustrates the extreme variability and uncertainty on the business side of hop culture.

FLAXSEED.

The acreage of flax in the United States in 1902 was 3,739,700 acres, producing 29,284,880 bushels; 15,552,000 bushels, or more than a half of the crop, was raised in the State of North Dakota, and the production of this State with that of Minnesota and South Dakota was nearly 88 per cent of the crop of the entire country. The high prices of the two previous years were well maintained in the leading markets of the United States, and the average price for the past three years shows a noticeable increase over the ten preceding years.

Flax crop of the countries named, 1899–1901.

Country.	Seed.			Fiber.		
	1899.	1900.	1901.	1899.	1900.	1901.
	Bushels.	*Bushels.*	*Bushels.*	*Pounds.*	*Pounds.*	*Pounds.*
United States *a*	19,979,000	20,000,000	24,000,000	....	....	....
Manitoba	315,000	169,000	275,000	....	....	....
Mexico	107,000	197,000	*a* 150,000	....	....	....
Argentina	8,639,000	8,865,000	15,354,000	....	....	....
Total America	29,040,000	29,231,000	39,779,000	....	....	....
Ireland	....	....	....	16,034,000	22,804,000	14,868,000
Sweden	66,000	63,000	*b* 67,000	3,354,000	*b* 3,162,000	*b* 3,386,000
Netherlands	*c* 254,000	347,000	*c* 254,000	*c* 10,855,000	*c* 15,106,000	*b* 12,056,000
Belgium	449,000	*d* 402,000	*d* 402,000	47,989,000	37,832,000	*d* 37,832,000
France	345,000	493,000	611,000	27,834,000	42,804,000	54,683,000
Italy *e*	....	....	....	41,917,000	41,917,000	41,917,000
Austria	735,500	895,000	1,131,000	92,067,000	110,954,000	122,267,000
Hungary	240,500	165,000	164,000	12,821,000	13,436,000	22,144,000
Croatia-Slavonia	26,500	28,500		7,921,000	8,555,000	
Total Austria-Hungary	1,002,500	1,088,500	1,295,000	112,809,000	132,945,000	144,411,000
Roumania	34,500	260,000	554,000	....	610,000	1,434,000
Bulgaria	600	*d* 23,000	*d* 23,000	27,000	*d* 2,116,000	*d* 2,116,000
Servia *f*	11,000	11,000	11,000	1,156,000	1,156,000	1,156,000
Russia	18,022,000	20,670,000	16,194,000	876,788,000	1,015,718,000	768,250,000
Total Europe	20,184,600	23,357,500	19,411,000	1,138,763,000	1,316,170,000	1,082,109,000
British India	17,116,000	11,827,000	13,041,000	....	....	....
Algeria	7,000	10,000	10,000	....	....	....

RECAPITULATION.

America	29,040,000	29,231,000	39,779,000	....	....	....
Europe	20,184,600	23,357,500	19,411,000	1,138,763,000	1,316,170,000	1,082,109,000
British India	17,116,000	11,827,000	13,041,000	....	....	....
Algeria	7,000	10,000	10,000	....	....	....
Total	66,347,600	64,425,500	72,241,000	1,138,763,000	1,316,170,000	1,082,109,000

a Commercial estimate.
b Average, 1898–1900.
c Average, 1896–1898.
d Average, 1897–1899.
e Average 1892–1895.
f 1897 figures.

Acreage, production, and value of flaxseed in the United States in 1902.

States and Territories.	Acreage.	Yield per acre.	Production.	Price per bushel, Dec. 1.	Farm value Dec. 1.
	Acres.	*Bushels.*	*Bushels.*	*Cents.*	*Dollars.*
Wisconsin	41,000	12.1	496,100	120	595,320
Minnesota	667,500	10.4	6,942,000	107	7,427,940
Iowa	97,500	7.9	770,250	105	808,762
Missouri	65,700	5.0	328,500	104	341,640
Kansas	190,200	6.4	1,217,280	101	1,229,453
Nebraska	14,500	8.0	116,000	113	131,080
South Dakota	427,500	7.5	3,206,250	114	3,655,125
North Dakota	2,160,000	7.2	15,552,000	103	16,018,560
Montana	12,500	9.0	112,500	68	76,500
Idaho	34,500	9.2	317,400	97	307,878
Oregon	2,300	6.8	15,640	122	19,081
California	1,100	15.0	16,500	105	17,325
Oklahoma	19,800	7.7	152,460	95	144,837
Indian Territory	5,600	7.5	42,000	98	41,160
United States	3,739,700	7.83	29,284,880	105	30,814,661

Monthly average prices of flaxseed in Chicago.[a]

[Cents per bushel.]

Month.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.
January	119¼	95¾	112¾	137¾	140¾	91¼	75⅝	124	115¼	152	166½	165½
February	122¼	95⅝	120	138½	141¼	90¾	75¾	126	117	159	168	168½
March	120	99	119¼	134½	140	88	78¾	120⅝	119½	162½	157½	168½
April	120¼	97	114½	126	140½	90¼	75¾	124	118½	170½	161	172½
May	115¼	102⅜	107¾	131½	147¾	86	77⅞	131	109¾	178	169¼	168½
June	108¾	104¼	109	138¾	149¾	79¼	77½	113	105¼	177	179	165
July	103¼	101¾	107	128¼	133	73	83	96¾	100¾	165	184½	155
August	104½	102¼	94⅝	125¾	107¾	68⅜	103⅞	89	108¼	141	162½	146
September	96½	106¼	101¾	136	97⅜	70⅞	103¼	89¾	112¾	150½	152	135¾
October	95½	109⅝	102	145	94¼	74¼	99¼	98⅛	123¼	166¾	149½	121½
November	94⅜	109	108¾	146½	92⅛	75⅛	106¼	101¾	133⅜	172	146¼	118
December	94¾	109¼	128¼	145½	93	75½	113¼	108⅜	145	162¼	149¾	119½
Yearly average	107⅞	102⅝	110½	136	123⅛	80¼	89⅛	110⅛	117⅜	163 1/24	162⅛	150⅜

[a] This table exhibits average cash prices for the past twelve years. The monthly prices are the means between the lowest and highest prices for each month, and the yearly prices are the averages of the monthly averages.

New Zealand Flax.

The growing of New Zealand flax has been introduced in California, and it is worth while to keep clear the distinction between this and the better-known common flax. The plant is like a lily, and is often called the flax-lily. It is a perennial, native of New Zealand, and grows best on rich lowlands near water courses. It will not stand severe cold weather.

The fiber of the leaves is fine and strong and is used for making ropes, twine, mats, and cloth. To obtain it, the leaves are cut and the fiber removed by some mechanical process. This is done most rapidly by beating and mashing the leaves in water. Machinery for this purpose is now in use, and the manufacture in New Zealand of flax fiber of this kind bids fair to develop rapidly.

Wholesale prices of flaxseed per bushel in leading cities of the United States, 1898–1902.

Date.	St. Louis. Prime. Low.	St. Louis. Prime. High.	Cincinnati. Low.	Cincinnati. High.	Chicago. No. 1. Low.	Chicago. No. 1. High.	Milwaukee. Low.	Milwaukee. High.	Duluth. Low.	Duluth. High.
1898.										
January	$1.13	$1.32	$0.85	$0.90	$1.16	$1.32	$1.19	$1.32	$1.16¼	$1.28
February	1.19	1.22	.85	.90	1.21¼	1.30½	1.25½	1.30¼	1.25	1.27
March	1.12	1.16	.85	.90	1.15¾	1.25½	1.18	1.25¾	1.17	1.22
April	1.12	1.28½	.85	.90	1.16¼	1.31½	1.18½	1.31	1.17¼	1.29
May	1.26½	1.36½	.85	.90	1.23	1.39	1.26	1.39	1.21	1.35
June	1.00	1.19	.85	.90	1.04	1.22	1.05½	1.22½	1.01	1.19
July	.84	1.01	.85	.90	.86½	1.07	.90	1.04½	.90	1.06
August	.84	.88	.80	.85	.85	.93	.88	.93	.88¼	.93¾
September	.84	.88	.80	.80	.86¼	.93	.89	.92¾	.90¼	.90½
October	.86	.98¾	.80	.80	.89¼	1.07	.90½	1.07	.87¼	1.03½
November	.91½	1.01¼	.80	.90	.95	1.08½	.98	1.08	.95	1.03
December	.91¾	1.07	.90	.90	.97¾	1.19	1.03½	1.19	.98	1.12¼
1899.										
January	1.08	1.13½	.90	.90	1.10½	1.20	1.15	1.20	1.11	1.16½
February	1.11	1.12½	.90	.90	1.13½	1.20½	1.18	1.20½	1.15	1.18
March	1.10	1.17	.90	1.00	1.14	1.25	1.18	1.24½	1.16	1.21
April	1.10	1.16	1.00	1.00	1.12	1.25	1.17	1.25	1.14¼	1.29
May	.98	1.12½	.90	1.00	1.02	1.17½	1.03½	1.17½	.99½	1.14
June	.95	1.00	.90	.90	1.00½	1.10	1.03	1.09	.90	1.07
July	.93	.98	.90	.90	.97	1.04½	.99	1.05	.99	1.02
August	.93	1.14½	.90	.90	.96½	1.26	1.00	1.20	1.00	1.09
September	1.02	1.15	.90	.90	1.01½	1.21	1.06	1.20	1.02	1.12½
October	1.12	1.28½	.90	1.00	1.14	1.32½	1.14	1.32½	1.11	1.27
November	1.26	1.30	1.00	1.00	1.27½	1.39¼	1.26½	1.39	1.23	1.38
December	1.34	1.46	1.00	1.00	1.39	1.51	1.39	1.52	1.30	1.42
1900.										
January	1.45	1.50	1.00	1.00	1.48	1.56	1.42	1.56	1.40	1.50
February	1.52	1.58	1.00	1.00	1.58	1.60	1.50	1.60	1.51	1.51¼
March	1.57	1.62	1.00	1.00	1.60	1.65	1.45	1.65	1.56	1.64
April	1.62	1.70	1.00	1.20	1.65	1.75	1.62½	1.73	1.64	1.73
May	1.62	1.65	1.20	1.20	1.76	1.80	1.65	1.80	1.70	1.80
June	1.55	1.58	1.20	1.30	1.74	1.80	1.72½	1.80	1.80	1.80
July	1.35	1.60	1.20	1.30	1.50	1.80	1.42	1.80	1.40	1.80
August	1.25	1.45	1.20	1.20	1.32	1.50	1.30	1.42	1.28½	1.44
September	1.42	1.56½	1.20	1.30	1.41½	1.59½	1.42½	1.75	1.43	1.59
October	1.46	1.75	1.30	1.30	1.47½	1.86	1.48½	1.86	1.48½	1.87
November	1.50	1.78	1.30	1.30	1.60	1.84	1.60	1.82	1.59½	1.85½
December	1.62	1.62	1.30	1.45	1.53½	1.71	1.54	1.68	1.60	1.80½
1901.										
January	1.50	1.72	1.30	1.45	1.56	1.77	1.45	1.76	1.57	1.73
February	1.58	1.72	1.30	1.50	1.60	1.76	1.60	1.75	1.59	1.72½
March	1.50	1.60	1.35	1.50	1.52	1.63	1.45	1.63½	1.58½	1.61
April	1.49	1.52	1.20	1.50	1.52	1.70	1.45	1.70	1.54½	1.76½
May	1.56	1.67	1.20	1.20	1.64½	1.74	1.55	1.75	1.67	1.78
June	1.67	1.68	1.20	1.30	1.70	1.88	1.35	1.88	1.50	1.88
July	1.50	1.65	1.30	1.30	1.79	1.90	1.75	1.88	1.75	1.88
August	1.37	1.65	1.30	1.40	1.40	1.85	1.48	1.83	1.48	1.75
September	1.37	1.38	1.25	1.35	1.38	1.66	1.40	1.65	1.37	1.64
October	1.38	1.48	1.25	1.25	1.41	1.58	1.44	1.63	1.35	1.55½
November	....	....	1.25	1.30	1.40	1.52½	1.40	1.52½	1.33	1.50
December	....	....	1.30	1.30	1.38½	1.61	1.30	1.61	1.34½	1.56½
1902.										
January	....	....	1.30	1.40	1.58	1.73	1.61	1.73	1.56½	1.71½
February	....	....	1.30	1.40	1.63	1.74	1.66	1.73	1.65	1.72
March	....	....	1.30	1.40	1.63	1.74	1.68	1.74	1.65	1.74
April	....	....	1.30	1.40	1.65	1.80	1.74	1.80	1.72	1.78
May	1.50	1.65	1.30	1.40	1.58	1.79	1.76	1.79	1.70	1.77
June	1.50	1.50	1.25	1.35	1.54	1.76	1.73	1.76	1.69	1.76½
July	1.41	1.50	1.30	1.40	1.36	1.74	1.43	1.74	1.35	1.66
August	1.32½	1.45	1.25	1.30	1.37	1.55	1.40	1.55	1.35	1.50
September	1.22	1.38	1.25	1.25	1.25½	1.46	1.25	1.45	1.24½	1.47
October	1.12	1.25	1.25	1.25	1.15	1.28	1.19	1.28	1.15¼	1.27¾
November	1.11	1.14½	1.25	1.25	1.13	1.23	1.18	1.23	1.15½	1.20
December	1.11	1.14	1.25	1.25	1.14	1.25	1.20	1.25	1.16	1.21½

SUGAR.

Sugar crop of the countries named, 1898–1899 to 1902–1903.

[In tons of 2,240 pounds.]

Country.	1898–1899.	1899–1900.	1900–1901.	1901–1902.	1902–1903.
CANE SUGAR.					
United States:					
Louisiana	245,511	147,164	270,338	310,000	280,000
Porto Rico	53,826	35,000	80,000	85,000	100,000
Hawaiian Islands	252,507	258,521	321,461	317,509	315,000
Cuba, crop	345,260	308,543	635,856	850,181	940,000
British West Indies:					
Trinidad, exports	53,430	42,210	52,673	51,077	51,000
Barbados, exports	45,789	50,000	55,360	43,750	38,500
Jamaica	27,000	27,000	30,000	30,000	30,000
Antigua and St. Kitts	22,000	18,000	25,000	25,000	25,000
French West Indies:					
Martinique, exports	31,630	30,000	39,750	34,942	28,000
Guadeloupe	39,390	40,000	39,000	41,000	41,000
Danish West Indies:					
St. Croix	12,000	12,020	13,000	13,000	13,000
Haiti and Santo Domingo	50,000	45,000	45,000	45,000	45,000
Lesser Antilles (not named above)	8,000	8,000	8,000	8,000	8,000
Mexico	50,000	78,000	95,000	100,000	115,000
Central America:					
Guatemala	11,000	12,000	9,000	10,000	10,000
San Salvador	4,500	5,000	5,000	5,000	5,000
Nicaragua	3,750	4,000	3,500	4,000	4,000
Costa Rica	750	1,000	1,500	1,500	1,500
South America:					
British Guiana (Demerara), exports	82,000	90,079	84,559	121,948	125,000
Dutch Guiana (Surinam)	6,000	9,600	13,000	12,750	13,000
Venezuela	....	2,000	3,000	3,000	3,000
Peru, exports	61,910	100,381	110,695	113,596	115,000
Argentina	72,000	91,507	114,252	135,000	120,000
Brazil	154,495	322,000	320,000	345,000	187,500
Total in America	1,632,748	1,737,025	2,374,944	2,706,253	2,613,500
Asia:					
British India, exports	10,000	10,000	15,000	15,000	15,000
Siam	7,000	7,000	7,000	7,000	7,000
Java, crop	689,281	721,993	709,928	767,130	842,812
Philippine Islands, exports	93,000	62,785	55,400	78,637	90,000
Total in Asia	799,281	801,778	787,328	867,767	954,812
Australia and Polynesia:					
Queensland	164,241	124,070	92,554	120,858	75,000
New South Wales	28,000	15,500	19,000	18,000	18,000
Fiji Islands, exports	34,000	31,000	33,000	31,000	35,000
Total Australia and Polynesia	226,241	170,570	144,554	169,858	128,000
Africa:					
Egypt	87,900	98,500	94,880	96,200	90,000
Mauritius	186,487	157,025	175,267	147,828	140,000
Reunion	37,781	35,000	35,000	35,000	35,000
Total in Africa	312,168	290,525	305,147	279,028	265,000
Europe:					
Spain	25,000	33,215	28,000	28,000	28,000
Total cane-sugar production (Willett & Gray)	2,995,438	3,033,113	3,639,973	4,050,906	3,989,312
BEET SUGAR.					
Europe beet-sugar production (Licht):					
Germany	1,721,718	1,798,631	1,984,186	2,299,408	1,730,000
Austria	1,051,290	1,108,007	1,094,043	1,302,038	1,025,000
France	830,132	977,850	1,170,332	1,183,420	880,000
Russia	776,066	905,737	918,838	1,110,000	1,275,000
Belgium	244,017	302,865	333,119	345,000	240,000
Holland	149,763	171,029	178,081	203,172	125,000
Other countries	209,015	253,929	367,919	400,000	355,000
Total in Europe	4,982,001	5,518,048	6,046,518	6,843,038	5,630,000

Sugar crop of the countries named, 1898–1899 to 1902–1903—Continued.

Country.	1898–1899.	1899–1900.	1900–1901.	1901–1902.	1902–1903.
BEET SUGAR—continued.					
United States beet-sugar production (Willett & Gray):					
California	16,436	37,938	25,451	62,723	70,909
Nebraska	4,721	4,591	4,406	6,660	7,768
Utah	5,764	8,574	7,630	12,748	15,625
New Mexico	550	446	....	....	....
New York	1,030	1,607	3,669	4,049	2,500
Michigan	2,253	14,699	23,533	46,692	57,678
Minnesota	891	2,053	1,186	2,455	3,393
Oregon	826	982	888	1,250	1,964
Illinois	....	804	1,150	....	....
Colorado	....	804	5,982	19,977	29,643
Washington	....	446	625	857	1,518
Ohio	....	....	1,339	3,126	1,339
Wisconsin	....	....	....	2,589	3,463
Total United States	32,471	72,944	75,859	163,126	195,800
Total cane and beet sugar	8,009,910	8,624,105	9,762,350	11,057,070	9,815,112

Quantity and value of sugar imported into the United States from the principal sources of supply during each fiscal year from 1898 to 1902, inclusive.

[From Division of Foreign Markets.]

QUANTITY.

Countries from which imported.	Annual average, 1898–1902.	Year ended June 30—					Per cent in 1902.
		1898.	1899.	1900.	1901.	1902.	
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	
Cuba	778,569,257	440,225,111	663,543,657	705,456,230	1,099,404,363	984,216,925	32.46
Dutch East Indies	837,014,235	621,731,462	986,438,330	1,162,202,854	777,986,990	636,711,538	21.00
Brazil	182,690,904	139,426,285	41,222,162	89,684,600	293,327,013	349,794,460	11.54
Germany	473,617,086	175,275,440	667,127,773	590,984,996	716,824,596	217,872,627	7.19
British West Indies	225,480,864	231,401,746	267,565,738	200,479,351	232,989,234	194,968,251	6.43
British Guiana	158,316,511	139,145,529	138,152,464	149,715,600	183,331,202	181,237,759	5.98
Austria-Hungary	88,262,040	2,788,767	69,397,343	96,130,457	161,174,865	111,818,771	3.69
Santo Domingo	109,505,968	94,336,444	112,213,037	122,206,692	107,193,244	111,580,425	3.68
Peru	73,192,632	8,544,857	50,080,303	75,155,975	129,534,403	102,647,624	3.38
Egypt	78,251,580	52,354,144	141,940,690	74,015,702	63,389,981	59,557,384	1.96
Dutch Guiana	21,590,207	25,636,341	38,124,370	13,265,520	14,063,215	16,861,587	.56
Danish West Indies	18,892,850	14,832,991	22,711,543	21,664,980	19,217,052	16,037,682	.53
United Kingdom	15,113,161	21,106,706	16,685,790	9,375,569	17,272,407	11,125,336	.37
Netherlands	16,090,717	38,659,827	6,894,728	153,860	25,327,230	8,967,942	.29
Guatemala	3,702,118	4,921,135	4,477,566	3,126,580	1,734,044	4,251,269	.14
Salvador	1,452,667	....	2,471,012	61,700	992,150	3,738,472	.12
Canada	1,490,446	717,532	2,020,001	878,778	1,399,269	2,436,647	.08
Chinese Empire	6,567,625	7,161,664	10,758,164	4,606,743	7,914,450	2,397,107	.08
Nicaragua	1,138,081	482,628	406,252	719,107	2,784,515	1,297,904	.04
Russia, European	9,955,772	242,575	14,800,295	866,788	32,770,130	1,099,072	.04
Hongkong	3,014,099	4,183,246	5,084,695	2,419,268	2,536,672	846,618	.03
Belgium	17,434,920	1,366,370	30,000	15,198,903	70,099,676	479,655	.01
Mexico	1,947,305	3,059,018	3,088,609	1,892,029	1,358,503	338,368	.01
Philippine Islands	29,344,551	29,489,600	51,625,280	49,490,542	4,693,333	11,424,000	.38
Hawaii	a488,971,200	499,776,895	462,423,600	504,713,105	(b)	(b)	....
Porto Rico	a92,739,539	98,452,421	107,208,014	72,558,181	(b)	(b)	....
Other sources	37,468,890	34,602,117	93,759,153	51,062,420	7,687,300	208,452	....
Total	3,539,035,933	2,689,920,851	3,980,250,569	4,018,086,530	3,975,005,840	3,031,915,875	100.00

a Annual average, 1898–1900. b No longer included in the returns of foreign trade.

Quantity and value of sugar imported into the United States from the principal sources of supply during each fiscal year from 1898 to 1902, inclusive—Continued.

VALUE.

Countries from which imported.	Annual average, 1898–1902.	Year ended June 30— 1898.	1899.	1900.	1901.	1902.	Per cent in 1902.
	Dollars.	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	
Cuba	17,812,688	9,828,607	16,412,088	18,243,644	26,373,690	18,205,411	33.06
Dutch East Indies	16,905,787	11,250,181	19,817,646	24,170,081	16,965,511	12,325,518	22.39
Brazil	3,015,619	2,317,990	810,276	1,693,588	5,347,503	4,908,735	8.92
Germany	9,823,398	3,520,796	14,095,417	12,346,734	15,556,811	3,597,234	6.53
British Guiana	3,692,507	3,045,666	3,461,889	3,779,398	4,803,479	3,372,104	6.13
British West Indies	4,698,097	4,552,454	6,049,479	4,603,409	5,058,565	3,226,575	5.86
Austria-Hungary	1,940,260	67,831	1,485,037	2,132,790	3,727,094	2,288,547	4.16
Santo Domingo	2,615,160	2,030,239	2,659,456	3,365,061	2,959,067	2,061,977	3.75
Peru	1,425,461	148,599	921,430	1,444,784	2,702,180	1,910,311	3.47
Egypt	1,929,644	1,230,071	3,570,343	1,843,077	1,653,695	1,351,038	2.45
Danish West Indies	450,454	312,446	556,562	544,985	460,694	377,581	.69
Dutch Guiana	529,225	585,326	953,047	375,633	382,876	349,242	.63
Netherlands	417,891	957,908	176,013	4,151	718,422	232,963	.42
United Kingdom	358,461	504,714	434,237	228,447	431,959	192,945	.35
Canada	99,599	32,589	139,023	94,809	108,137	123,441	.22
Guatemala	106,601	212,637	118,262	70,416	41,286	90,402	.16
Salvador	36,173	....	63,459	1,521	28,200	87,683	.16
Chinese Empire	178,507	176,751	296,574	125,986	229,795	63,429	.12
Russia, European	245,628	5,736	340,815	22,993	829,401	29,193	.05
Nicaragua	26,469	8,195	11,404	18,663	65,483	28,602	.05
Hongkong	82,742	107,295	141,767	69,697	70,753	24,202	.04
Belgium	424,546	31,909	788	353,699	1,724,724	11,607	.02
Mexico	37,632	48,682	52,995	41,082	35,994	9,408	.02
Philippine Islands	513,591	381,279	969,323	925,335	103,857	188,159	.34
Hawaii	[a] 18,115,095	16,660,412	17,292,723	20,392,150	([b])	([b])	......
Porto Rico	[a] 2,286,402	1,913,742	2,495,849	2,449,616	([b])	([b])	......
Other sources	640,310	540,694	1,638,218	909,225	108,624	4,790	.01
Total	80,247,348	60,472,749	94,964,120	100,250,974	90,487,800	55,061,097	100.00

[a] Annual average, 1898–1900. [b] No longer included in the returns of foreign trade.

Production of beet and cane sugar in the United States. [a]

Years.	Beet.	Cane (Louisiana).	Total. [b]
	Tons. [c]	*Tons.* [c]	*Tons.* [c]
1883–84	535	128,443	128,978
1884–85	953	94,376	95,329
1885–86	600	127,958	128,558
1886–87	800	80,859	81,659
1887–88	255	157,971	158,226
1888–89	1,861	144,878	146,739
1889–90	2,203	130,413	132,616
1890–91	3,459	215,844	219,303
1891–92	5,356	160,937	166,293
1892–93	12,018	217,525	229,543
1893–94	19,950	265,836	285,786
1894–95	20,092	317,334	337,426
1895–96	29,220	237,721	266,941
1896–97	37,536	282,009	319,545
1897–98	40,398	310,313	350,711
1898–99	32,471	248,658	281,129
1899–1900	72,972	142,485	215,457
1900–1901	76,859	270,338	347,197
1901–2	163,126	310,000	473,126
1902–3	195,463	280,000	475,463

[a] Data as to beet sugar are obtained from the following sources: For 1899–1900, from the Eleventh Census; for 1897–98, from a special report of the Department of Agriculture; and for other years from Willett and Gray. Data as to cane sugar are from the following sources: For 1889–90, 1898–99, and 1899–1900, from the Eleventh and Twelfth censuses; for 1901–2 and 1902–3, from Willet and Gray; for other years, from Bouchereau's Annual Louisiana Sugar Reports (the figures for 1892–93 being taken from his revised statement).

[b] These figures do not include cane sugar produced outside of Louisiana; in 1889–90 such sugar amounted to 4,089 tons and 1899–1900 to 1,510 tons.

[c] Tons of 2,240 pounds.

RICE.

Wholesale prices of rice per pound, 1898–1902.

Date.	New York. Domestic (good). Low.	New York. Domestic (good). High.	Cincinnati. Louisiana. Low.	Cincinnati. Louisiana. High.	Memphis. Not classed by name. Low.	Memphis. Not classed by name. High.	New Orleans. Low.	New Orleans. High.
1898.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	4⅞	5	5¾	6¼	4	7	4¼	4½
February	5	5	5¾	6¼	4	7	4¼	4¾
March	5	5	5¾	6¼	4	7	4½	4¾
April	5	5⅝	5¾	6½	3¾	7½	4½	5⅜
May	5⅝	5⅝	6½	7	4¼	8	5¼	5½
June	5⅝	5⅝	6	7	5¼	8	[illegible]	[illegible]
July	5⅝	5⅝	6	6½	5¼	8	5⅜	5½
August	5¼	5⅝	5½	6½	4¼	6½	5	5½
September	5	5	5½	6	4¼	6½	4½	5
October	5	5¼	5½	6	4¼	6½	4¾	5
November	5¼	5½	5½	6	4¼	7	4¾	5
December	5¼	5½	5½	6	4¼	7	4¾	5
1899.			Prime.					
January	5½	5½	5¾	6½	4½	7	4¼	5
February	5	5¼	5¾	6½	4½	7	4¼	4¾
March	5¼	5¼	5¾	6¾	4¾	6½	4¼	4¾
April	5¼	5¼	5¾	6¾	3¾	6½	4¼	4¾
May	5¼	5¼	5½	6¾	3¾	6½	4¼	4¾
June	5¼	5¼	5½	6¼	4½	7	4¼	4¾
July	5¼	5¼	5½	6	4½	7	4¼	4¾
August	5	5¼	5½	6	4½	7	4¼	5
September	5	5	5½	6	4½	7	3¾	5¾
October	5	5⅛	5½	6	3½	7	3¾	6⅜
November	4¾	5	5¼	6	3	7	3¾	6⅜
December	4¾	4¾	5½	6	2½	7	3¾	6⅜
1900.			Louisiana.					
January	4¾	4¾	5½	6	3	7	3¾	6⅜
February	4¾	4¾	5½	6	3	7	3¾	6⅜
March	4¾	4⅝	5½	6	3½	7	3¾	6⅜
April	4⅝	4⅝	5½	6	3¾	6½	3¾	6¼
May	4⅝	4⅝	5½	6	3	7	3¾	6½
June	4¾	4¾	5½	6	3	7½	4½	6⅝
July	4¾	4¾	5½	6	3	7½	4½	6⅝
August	4¾	4¾	5½	6	3	7½	4¼	6⅝
September	4¾	4⅞	5½	6	3½	7½	4¼	6¼
October	4¾	4⅞	5½	6	4	7½	4¼	6
November	4¾	5	5½	6	4	7	4¼	6
December	5	5	5½	6	3½	7½	4¼	6
1901.								
January	5	5	6½	7½	....	....	....	....
February	4⅞	5	6½	7½	....	....	....	....
March	4⅞	4⅞	6¾	7¼	....	....	....	....
April	4⅞	4⅞	6¾	7¼	....	....	....	....
May	4⅞	4⅞	6¾	7¼	....	....	....	....
June	4⅞	4⅞	6¾	7¼	....	....	....	....
July	4¾	5	6¾	7¼	....	....	....	....
August	5	5	6¾	7¼	....	....	....	....
September	5	5	6¾	7¼	....	....	....	....
October	5	5	6¾	7¼	....	....	....	....
November	4⅞	4⅞	6¾	7¼	....	....	....	....
December	4¾	4¾	6¾	7¼	....	....	....	....
1902.			Prime.					
January	4¾	4¾	5½	6½	....	....	....	....
February	4¾	4¾	5½	6½	....	....	....	....
March	4¾	4¾	5½	6½	....	....	....	....
April	4¾	4¾	5½	6½	....	....	....	....
May	4¾	5	5½	6½	....	....	....	....
June	4⅞	5¼	5½	6½	....	....	....	....
July	4⅞	5¼	5½	6½	....	....	....	....
August	4⅞	4⅞	5½	6½	....	....	....	....
September	4⅞	4⅞	5¼	6½	....	....	....	....
October	4⅞	4⅞	5¼	5¾	....	....	....	....
November	4⅞	4⅞	5¼	5¾	....	....	....	....
December	5	5	5¼	5¾	....	....	....	....

BEANS.

Wholesale prices of beans per bushel in leading cities of the United States, 1898–1902.

Date.	New York.		Cincinnati.		Chicago.		Detroit.		San Francisco.	
	Pea.		Pea.		Pea.		Pea.		Small white, per cwt.	
	Low.	High.	Low.	High.	Low.	High.	Low.	High.	Low.	High.
1898.										
January	$1.00	$1.06¾	$1.10	$1.20	$0.80	$1.02	$0.92	$1.00	$1.25	$1.55
February	1.00	1.08	1.10	1.20	.80	1.00	.90	.92	1.65	1.90
March	.99	1.10	1.10	1.20	.88	1.00	.90	.95	1.85	2.10
April	.99½	1.13⅛	1.10	1.35	.85	1.31	.92	1.08	1.90	2.15
May	1.18⅜	1.41	1.30	1.55	1.08	1.30	1.13	1.30	2.00	2.20
June	1.12	1.30	1.20	1.40	.78	1.21	.98	1.05	2.00	2.20
July	1.03	1.24	1.20	1.30	.80	1.15	1.05	1.10	2.00	2.15
August	1.10½	1.27	1.10	1.20	.90	1.15	.97	1.10	2.00	2.15
September	1.05	1.20⅝	1.10	1.20	.90	1.05	1.00	1.00	2.00	2.15
October	1.00	1.24½	1.10	1.20	1.00	1.15	1.00	1.10	2.00	2.15
November	1.00	1.27	1.10	1.20	1.07	1.15	1.00	1.08	2.00	2.15
December	1.05	1.28	1.10	1.20	1.03	1.12	1.05	1.07	2.00	2.15
1899.										
January	1.07	1.27	1.10	1.20	1.03	1.16	1.06	1.13	2.10	2.25
February	1.10	1.26 13/16	1.05	1.20	1.13	1.25	1.06	1.20	2.15	2.25
March	1.10	1.35	1.05	1.45	1.16	1.25	1.15	1.20	2.15	2.25
April	1.10	1.33⅝	1.35	1.45	1.15	1.25	1.14	1.17	2.20	2.30
May	1.10	1.32 11/16	1.35	1.45	.90	1.20	1.01	1.17	2.15	2.20
June	1.10	1.29⅛	1.35	1.45	.90	1.13	1.01	1.06	2.00	2.10
July	1.14⅝	1.38¼	1.15	1.25	.98	1.18	1.04	1.11	2.15	2.20
August	1.24¼	1.36	1.15	1.25	1.00	1.15	1.05	1.11	2.15	2.25
September	1.32⅜	1.40	1.25	1.35	1.00	1.30	1.18	1.32	2.15	2.25
October	1.62	1.68¼	1.30	1.75	1.12	1.65	1.32	1.68	2.15	2.50
November	1.75	1.89	1.65	1.70	1.25	1.85	1.63	1.80	2.90	3.00
December	1.77⅝	2.00	1.65	1.70	1.60	1.87	1.78	1.80	2.90	3.00
1900.										
January	1.86½	2.06¼	2.25	2.40	1.70	1.85	1.78	2.05	2.85	3.00
February	1.98	2.13	2.40	2.40	1.90	2.10	1.98	2.05	3.15	3.25
March	1.90	2.11	2.20	2.40	1.90	2.10	2.00	2.00	3.15	3.35
April	1.90	2.15	2.10	2.15	1.95	2.20	2.00	2.08	3.40	3.50
May	1.85⅜	2.25	2.00	2.55	1.90	2.18	2.08	2.10	3.40	3.50
June	1.80	2.25	2.45	2.55	1.90	2.16	2.10	2.10	3.25	3.40
July	1.80	2.21¼	2.45	2.55	1.90	2.15	2.10	2.10	3.40	3.50
August	1.75¼	2.08	2.45	2.55	1.90	2.15	Not quoted.		3.50	3.65
September	1.79	2.07⅛	2.10	2.55	1.65	2.25	1.55	1.70	3.75	4.00
October	1.95	2.10	2.10	2.25	1.70	1.90	1.70	1.84	3.60	3.75
November	1.91	2.05	2.10	2.25	1.68	1.87	1.70	1.90	3.90	4.00
December	2.14	2.17	2.10	2.25	1.70	2.10	1.90	2.08	4.00	4.50
1901.										
January	2.25	2.35	2.50	2.55	1.75	2.20	1.85	2.15	3.60	4.70
February	2.20	2.27½	2.50	2.50	1.80	2.10	1.94	2.00	3.75	4.90
March	2.00	2.25	2.40	2.50	.90	2.02	1.80	1.88	3.60	4.90
April	2.00	2.12½	2.40	2.40	1.25	1.97	1.80	1.90	3.75	4.95
May	1.97½	2.10	2.40	2.40	1.25	1.90	1.74	1.80	3.70	4.95
June	1.95	2.12½	2.40	2.40	1.50	2.05	1.75	1.95	3.60	4.90
July	2.07½	2.25	2.40	2.40	1.60	2.50	1.85	2.40	3.40	5.00
August	2.30	2.77½	2.40	3.00	2.10	2.80	2.40	2.40	2.00	4.25
September	2.25	2.75	3.00	3.00	1.65	2.75	2.40	2.40	2.05	4.25
October	2.05	2.30	2.60	3.00	1.55	2.00	1.68	1.92	2.00	5.00
November	1.95	2.05	2.60	2.75	1.50	1.92	1.66	1.85	2.50	3.50
December	1.95	2.00	2.60	2.75	1.69	1.85	1.72	1.81	2.80	3.25
1902.									Lima.	
January	1.75	2.00	2.60	2.70	1.40	1.83	1.60	1.79	4.40	4.65
February	1.65	1.80	2.60	2.70	1.40	1.75	1.53	1.62	4.40	4.60
March	1.60	1.75	2.60	2.70	1.15	1.65	1.28	1.51	4.35	4.40
April	1.50	1.82½	2.30	2.70	.85	1.80	1.28	1.62	3.30	3.60
May	1.75	1.85	2.30	2.60	1.50	1.85	1.56	1.75	3.60	3.80
June	1.60	1.70	2.30	2.60	1.50	1.70	1.48	1.60	3.60	3.85
July	1.65	2.00	2.30	2.50	1.60	1.90	1.60	1.99	3.60	3.85
August	1.95	2.05	2.30	2.50	1.60	1.96	1.63	1.90	3.80	4.10
September	1.90	1.95	2.30	2.50	1.60	1.90	1.75	1.85	3.70	3.90
October	1.92½	2.45	2.25	2.50	1.78	2.49	1.70	1.98	4.10	4.35
November	2.30	2.45	2.20	2.40	2.15	2.30	1.66	1.88	4.20	4.50
December	2.25	2.37½	2.25	2.40	2.15	2.30	1.74	1.81	4.25	4.55

CLOVER SEED.

In 1901 prime clover seed had a range of $5.15 to $7.40 at Toledo; in 1902 it ranged at $3.90 to $7.10. The average of prices was not so high the past year as the year before; however, there was not any very material reaction. During the closing months of 1902 prices were considerably better than at the close of the previous year.

Wholesale prices of clover seed per 100 pounds (60 pounds to the bushel), 1898–1902.

Date.	New York.		Cincinnati.		Chicago.		Toledo.		Detroit.	
	Prime.		Prime.		Poor to choice.		Poor to choice (per bushel).		Per bushel.	
	Low.	High.	Low.	High.	Low.	High.	Low.	High.	Low.	High.
1898.										
January	$3.40	$3.55	$2.75	$3.00	$2.50	$5.40	$3.12½	$3.22½	$3.12½	$3.22½
February	3.45	3.45	2.75	3.00	2.50	5.40	3.05	3.20	3.05	3.20
March	3.45	3.50	2.45	2.90	2.00	5.15	2.85	3.07½	2.80	3.07½
April	3.50	3.50	2.45	2.65	2.50	5.00	2.85	3.15	2.85	3.12½
May	3.37½	3.62½	2.45	2.65	2.50	5.50	3.00	3.30	3.00	3.12½
June	3.50	3.62½	....	....	2.50	5.25	2.80	3.30	2.90	3.25
July	3.50	3.50	....	....	2.50	5.30	2.87½	3.30	2.90	3.30
August	3.50	3.50	....	....	2.00	5.40	3.20	3.32½	3.15	3.30
September	3.50	3.50	3.25	3.50	1.00	8.00	3.25	3.90	3.25	4.00
October	3.45	4.20	3.25	3.75	3.00	8.00	3.75	5.15	3.75	5.20
November	3.97½	4.20	3.25	3.75	1.25	7.75	4.25	4.65	4.55	4.90
December	3.81	3.97½	3.25	3.75	2.50	7.25	4.00	4.65	4.35	4.60
1899.										
January	6.50	6.75	3.00	3.75	3.00	7.00	4.00	4.72½	3.80	4.65
February	6.50	7.00	3.00	3.50	3.00	6.50	3.90	4.07½	3.85	4.15
March	6.25	6.75	2.85	3.40	2.50	6.10	3.42½	3.85	3.40	3.80
April	5.75	6.00	2.85	3.10	2.50	6.25	3.50	3.80	3.45	3.75
May	5.50	5.87½	2.75	3.10	3.00	6.40	3.50	3.85	3.50	4.00
June	5.50	5.50	2.75	3.00	3.00	6.65	3.77½	4.05	3.80	4.00
July	6.00	7.50	2.75	3.25	1.50	6.65	3.85	4.00	3.90	4.00
August	6.00	7.50	3.00	3.50	2.50	6.50	3.75	4.05	3.75	4.00
September	6.50	7.50	3.50	3.75	2.50	8.40	4.60	5.85	4.75	6.25
October	8.50	9.50	3.75	4.50	6.00	8.60	5.50	6.80	5.90	6.50
November	7.75	8.50	3.85	4.50	5.00	8.00	5.40	6.20	5.35	5.75
December	7.75	8.75	3.85	4.50	3.00	8.50	5.40	5.72	5.40	5.70
1900.	Per pound.									
January	.08¼	.08⅞	4.00	4.50	5.00	8.40	5.57½	5.80	5.60	5.75
February	.08⅞	.09	4.00	4.50	5.00	8.50	5.55	5.80	5.50	5.75
March	.09	.10	4.00	4.65	4.00	8.50	5.20	5.67½	5.20	5.50
April	.09¼	.09¼	4.00	4.65	5.00	7.75	4.95	5.15	4.80	5.05
May	Nominal.		4.00	4.20	4.00	7.50	5.00	5.00	4.80	4.90
June	Nominal.		4.00	4.50	4.50	8.00	5.10	5.30	4.90	5.35
July	Nominal.		4.25	4.50	4.50	8.00	5.50	5.50	5.10	5.35
August	.10¾	.10¾	4.25	5.20	4.50	8.40	5.40	6.20	5.75	6.55
September	.10¼	.10¾	4.80	5.75	5.00	9.75	6.10	6.10	6.55	6.90
October	.10¼	.10½	5.00	6.00	5.00	10.50	6.50	7.85	6.65	7.10
November	.10	.10½	5.00	5.70	5.00	10.00	6.15	6.40	6.75	6.90
December	.10	.10½	5.00	5.70	4.00	10.50	6.60	6.87½	6.70	6.80
1901.	Per 100 pounds, common to choice.						Prime.			
January	9.00	10.50	5.00	6.25	4.00	11.00	7.10	7.35	6.90	7.30
February	9.25	10.50	5.75	6.60	5.00	11.50	6.80	7.40	6.75	7.35
March	9.00	9.50	6.00	6.40	5.00	11.15	6.55	6.75	6.50	6.80
April	9.50	11.75	5.80	6.40	6.00	11.00	6.50	6.75	6.50	6.65
May	9.50	11.50	5.80	6.00	4.00	10.75	6.30	6.57½	6.00	6.50
June	9.50	10.50	....	....	6.00	9.50	6.40	6.50	6.00	6.00
July	9.50	10.50	....	....	6.00	10.00	6.20	6.60	6.00	6.25
August	9.50	11.25	6.00	6.00	7.00	10.40	5.80	6.00	5.85	6.50
September	....	....	4.50	5.80	4.50	9.85	5.15	5.90	5.15	5.90
October	....	....	4.50	5.10	4.50	8.75	5.15	5.60	5.15	5.60
November	....	....	4.60	5.25	5.00	9.25	5.40	5.65	5.40	5.65
December	....	....	4.75	5.60	6.00	9.50	5.62½	5.90	5.65	5.90
1902.	No quotations.									
January	....	....	8.65	9.60	7.00	10.00	4.25	6.15	5.70	6.10
February	....	....	8.65	9.20	6.50	9.70	4.95	5.80	5.55	5.80
March	....	....	8.00	9.20	6.00	8.80	4.30	5.65	5.10	5.55
April	....	....	7.10	8.35	4.00	8.35	3.90	5.30	4.90	5.20
May	....	....	6.85	7.50	5.50	8.35	3.90	5.22½	5.00	5.20
June	....	....	6.85	7.30	6.00	8.35	4.00	5.25	Not quoted.	
July	....	....	6.85	7.50	6.00	8.40	4.10	5.30	Not quoted.	
August	....	....	7.10	8.35	6.00	9.10	4.20	5.60	Not quoted.	
September	....	....	7.10	8.35	7.00	9.50	4.25	5.65	5.15	5.90
October	....	....	7.50	8.75	7.00	11.35	4.70	7.00	5.15	5.60
November	....	....	7.50	9.20	8.00	11.15	4.75	7.10	5.35	5.65
December	....	....	8.35	9.20	8.00	10.90	5.50	6.85	5.60	5.90

TIMOTHY SEED.

Prices of timothy seed ranged exceptionally high in 1902. In 1901, the price surpassed any previous record, but the past year it went 80 cents better—$7.35 per bushel in Chicago. The yearly average price reached the high figures of $5.50.

Wholesale prices of timothy seed per 100 pounds (45 pounds to the bushel), 1898–1902.

Date.	New York.		Cincinnati.		Chicago.		Milwaukee.	
	Per bushel.		Per 100 lbs.		Per 100 lbs.		Per 100 lbs.	
	Low.	High.	Low.	High.	Low.	High.	Low.	High.
1898.								
January	1.23\frac{3}{4}$	1.46\frac{1}{4}$	$1.15	$1.25	$2.65	2.82\frac{1}{2}$	$2.15	$2.85
February	1.23$\frac{3}{4}$	1.46$\frac{1}{4}$	1.15	1.25	2.77$\frac{1}{2}$	2.95	2.25	3.00
March	1.23$\frac{3}{4}$	1.46$\frac{1}{4}$	1.15	1.25	2.80	3.00	2.35	3.00
April	1.26$\frac{1}{2}$	1.59$\frac{3}{16}$	1.15	1.25	2.65	2.97$\frac{1}{2}$	2.35	3.00
May	1.35	1.68$\frac{3}{4}$	1.15	1.25	2.70	2.90	2.20	3.00
June	1.35	1.68$\frac{3}{4}$	....	....	2.60	2.80	2.00	2.90
July	1.30$\frac{3}{4}$	1.63$\frac{11}{16}$	....	....	2.55	2.60	2.00	2.60
August	1.30$\frac{1}{4}$	1.57$\frac{1}{16}$	1.08	1.17	2.30	2.65	1.75	2.70
September	1.16$\frac{9}{16}$	1.53$\frac{7}{16}$	.95	1.17	2.32$\frac{1}{2}$	2.50	1.50	2.50
October	1.12$\frac{1}{2}$	1.41$\frac{7}{8}$	.95	1.10	2.17$\frac{1}{2}$	2.37$\frac{1}{2}$	1.60	2.50
November	1.12$\frac{1}{2}$	1.35	.95	1.00	2.15	2.30	1.70	2.50
December	1.13$\frac{3}{8}$	1.35	.95	1.00	2.20	2.30	1.70	2.50
1899.								
January	1.14$\frac{5}{16}$	1.26$\frac{9}{16}$	.95	1.05	2.30	2.42$\frac{1}{2}$	1.70	2.50
February	1.13$\frac{15}{16}$	1.35	1.00	1.05	2.40	2.50	1.85	2.50
March	1.19$\frac{9}{16}$	1.35	1.00	1.05	2.25	2.40	1.75	2.50
April	1.12$\frac{1}{2}$	1.30	1.00	1.05	2.25	2.47$\frac{1}{2}$	1.75	2.75
May	1.12$\frac{1}{2}$	1.44$\frac{7}{8}$	1.00	1.05	2.25	2.40	1.90	2.65
June	1.12$\frac{1}{2}$	1.46$\frac{1}{4}$	....	....	2.30	2.40	1.90	2.65
July	1.18$\frac{13}{16}$	1.38$\frac{5}{8}$	....	....	2.40	2.50	1.90	2.80
August	1.24$\frac{3}{16}$	1.46$\frac{1}{4}$	1.10	1.15	2.40	2.55	1.75	2.80
September	1.23$\frac{3}{4}$	1.52$\frac{5}{8}$	1.10	1.15	2.35	2.50	1.80	2.60
October	1.23$\frac{3}{4}$	1.57$\frac{1}{2}$	1.03	1.15	2.35	2.50	1.80	2.45
November	....	....	1.03	1.07	2.37$\frac{1}{2}$	2.50	1.90	2.45
December	1.17	1.46$\frac{1}{4}$	1.03	1.07	2.40	2.45	1.85	2.50
1900.	Per 100 pounds.							
January	2.60	3.25	1.03	1.07	2.47$\frac{1}{2}$	2.55	2.00	2.50
February	2.50	3.50	1.03	1.12	2.40	2.55	2.00	2.50
March	2.50	3.50	1.05	1.12	2.32$\frac{1}{2}$	2.50	1.90	2.55
April	2.75	3.50	1.07	1.12	2.35	2.47$\frac{1}{2}$	1.90	2.55
May	2.75	3.50	1.07	1.12	2.40	2.55	1.90	2.60
June	2.75	3.50	1.07	1.12	2.40	3.40	2.00	3.15
July	Nominal.		1.15	1.40	3.00	3.40	2.65	3.25
August	Nominal.		1.35	1.80	3.00	4.02$\frac{1}{2}$	2.75	4.25
September	4.20	5.55	1.60	2.00	3.90	4.60	3.50	4.50
October	4.20	5.55	1.70	2.00	4.15	4.40	3.50	4.30
November	4.20	5.50	1.70	1.85	4.20	4.55	3.50	4.02
December	4.50	5.00	1.70	1.85	4.45	4.65	3.50	4.40
1901.								
January	4.50	5.00	1.70	2.00	4.60	4.77$\frac{1}{2}$	3.15	4.50
February	4.50	5.00	1.85	2.05	4.35	4.60	4.00	4.40
March	4.00	5.00	1.85	2.00	4.00	4.40	3.75	4.30
April	4.00	5.00	1.80	1.95	3.75	4.15	3.50	4.20
May	4.22	5.55	1.80	1.85	3.35	3.90	3.00	4.00
June	4.22	5.55	....	....	3.60	4.30	3.00	4.60
July	4.25	5.55	....	....	4.30	5.25	3.65	4.75
August	4.25	5.50	2.00	2.40	4.90	5.75	3.75	5.25
September	....	....	2.30	2.45	5.20	5.70	4.25	5.25
October	....	....	2.35	2.60	5.50	5.90	4.25	5.60
November	....	....	2.50	2.65	5.75	6.35	4.50	6.00
December	....	....	2.50	2.90	6.35	6.55	5.00	6.25
1902.	No quotations.							
January	....	....	6.10	6.40	5.00	6.55	5.50	6.25
February	....	....	6.10	6.40	5.00	6.60	5.50	6.25
March	....	....	6.10	6.40	5.00	7.00	5.50	6.60
April	....	....	6.40	6.60	4.50	7.10	6.00	6.75
May	....	....	....	....	5.00	7.35	5.50	6.75
June	....	....	....	....	4.50	6.35	5.00	6.25
July	....	....	....	....	4.50	5.75	4.00	5.75
August	....	....	3.90	4.40	3.25	5.75	3.75	5.00
September	....	....	3.80	4.00	2.00	4.75	2.75	4.10
October	....	....	3.30	3.65	2.00	4.25	2.50	3.75
November	....	....	3.40	3.65	2.00	4.10	3.00	3.75
December	....	....	3.40	3.65	2.00	4.25	3.00	3.75

Monthly average prices per bushel of timothy seed in Chicago.[a]

Month.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.
January	$2.78	$2.79	$4.42½	$4.25	$5.71¼	$3.68¾	$2.70	$2.73¾	$2.36¼	$2.51¼	$4.68¾	$6.40
February	2.82½	2.86	4.46¼	4.17½	5.75	3.75	2.65	2.86¼	2.45	2.47½	4.47½	6.50
March	2.83½	2.88	4.34	4.20	5.56¼	3.35	2.67½	2.90	2.32½	2.41¼	4.20	6.70
April	2.84	2.91⅓	4.13	4.27½	5.32½	3.25	2.85	2.81¼	2.36¼	2.41¼	3.95	7.02½
May	2.89	2.91½	3.87½	4.07½	5.25	3.25	2.90	2.80	2.32½	2.47½	3.62½	6.82½
June	2.86	2.97	3.75	4.37½	5.37½	3.05	2.73¾	2.70	2.35	2.90	3.95	6.05
July	2.76½	2.91½	3.97½	4.92½	5.80	3.02½	2.72½	2.57½	2.45	3.20	4.77½	5.60
August	2.80	4.26	3.52½	5.32½	4.80	2.87½	2.81¼	2.47½	2.47½	3.51¼	5.32½	4.80
September	2.71½	3.78	3.35	5.50	3.95	2.56¼	2.75	2.41¼	2.42½	4.25	5.45	4.10
October	2.56½	4.05½	3.32½	5.43¾	3.50	2.55	2.66¼	2.27½	2.42½	4.27½	5.70	3.95
November	2.68	4.14½	3.27½	5.52½	3.57½	2.56¼	2.66¼	2.22½	2.43¾	4.37½	6.05	3.92½
December	2.72½	4.40	3.85	5.60	3.52½	2.62½	2.68¾	2.25	2.42½	4.55	6.45	4.12½
Yearly average	2.77⅓	3.41	3.85⅔	4.80½	4.84⅚	3.04½	2.81¾	2.58½	2.40⅛	3.27 11/12	4.88⅔	5.50

[a] This table exhibits average cash prices for the past twelve years. The monthly prices are the means between the lowest and highest prices for each month, and the yearly prices are the averages of the monthly averages.

FARM ANIMALS AND THEIR PRODUCTS.

HORSES AND MULES.

Number and value of horses and mules, 1880–1903.

January 1—	Horses.		Mules.	
	Number.	Value.	Number.	Value.
1880	11,201,800	$613,296,611	1,729,500	$105,948,319
1881	11,429,626	667,954,325	1,720,731	120,096,164
1882	10,521,554	615,824,914	1,835,166	130,945,378
1883	10,838,111	765,041,308	1,871,079	148,732,390
1884	11,169,683	833,734,400	1,914,126	161,214,976
1885	11,564,572	852,282,947	1,972,569	162,497,097
1886	12,077,657	860,823,208	2,052,593	163,381,096
1887	12,496,744	901,685,755	2,117,141	167,057,538
1888	13,172,936	946,096,154	2,191,727	174,853,563
1889	13,663,294	982,194,827	2,257,574	179,444,481
1890	14,213,837	978,516,562	2,331,027	182,394,099
1891	14,056,750	941,823,222	2,296,532	178,847,370
1892	15,498,140	1,007,593,636	2,314,699	174,882,070
1893	16,206,802	992,225,185	2,331,128	164,763,751
1894	16,081,139	769,224,799	2,352,231	146,232,811
1895	15,893,318	576,730,580	2,333,108	110,927,834
1896	15,124,057	500,140,186	2,278,946	103,204,457
1897	14,364,667	452,649,396	2,215,654	92,302,090
1898	13,960,911	478,362,407	2,257,665	99,032,062
1899	13,665,307	511,074,813	2,134,213	95,963,261
1900	13,537,524	603,969,442	2,086,027	111,717,092
1901	16,744,723	885,200,168	2,864,458	183,232,209
1902	16,531,224	968,935,178	2,757,017	186,411,704
1903	16,557,373	1,030,705,959	2,728,088	197,753,327

Imports and exports of horses and mules, with average prices, 1892–1902.

Year ended June 30—	Imports of horses.			Exports of horses.			Exports of mules.		
	Number.	Value.	Average price.	Number.	Value.	Average price.	Number.	Value.	Average price.
1892	14,074	$2,455,868	$174.50	3,226	$611,188	$189.46	1,965	$238,591	$121.42
1893	15,451	2,388,267	154.57	2,967	718,607	242.20	1,634	210,278	128.69
1894	6,166	1,319,572	214.01	5,246	1,108,995	211.40	2,063	240,961	116.80
1895	13,098	1,055,191	80.56	13,984	2,209,298	157.99	2,515	186,452	74.14
1896	9,991	662,591	66.32	25,126	3,530,703	140.52	5,918	406,161	68.63
1897	6,998	464,808	66.42	39,532	4,769,265	120.64	7,473	545,331	72.97
1898	3,085	414,899	134.49	51,150	6,176,569	120.75	8,098	664,789	82.09
1899	3,042	551,050	181.15	45,778	5,444,342	118.93	6,755	516,908	76.52
1900	3,102	596,592	192.32	64,722	7,612,616	117.62	43,369	3,919,478	90.38
1901	3,785	985,738	260.43	82,250	8,873,845	107.89	34,405	3,210,267	93.31
1902	4,832	1,577,234	326.41	103,020	10,048,046	97.53	27,586	2,692,298	97.60

Number, average price, and total value of horses and mules in the United States, January 1, 1903, by States.

States and Territories.	Horses.			Mules.		
	Number.	Average price per head.	Value.	Number.	Average price per head.	Value.
Maine	108,573	$81.34	$8,830,879			
New Hampshire	54,007	77.83	4,203,166			
Vermont	86,517	72.24	6,249,993			
Massachusetts	70,875	82.39	5,839,544			
Rhode Island	10,759	91.24	981,599			
Connecticut	51,737	78.72	4,072,673			
New York	618,909	89.46	55,370,194	3,714	$88.35	$328,124
New Jersey	94,287	95.93	9,045,374	4,974	103.22	513,406
Pennsylvania	578,247	81.38	47,055,151	37,035	91.43	3,386,185
Delaware	33,730	67.03	2,260,899	5,229	92.21	482,186
Maryland	140,851	72.22	10,172,615	17,380	94.51	1,642,526
Virginia	262,532	65.96	17,317,008	42,019	83.39	3,503,870
North Carolina	162,438	71.16	11,558,399	138,048	85.54	11,808,815
South Carolina	72,540	72.13	5,232,590	103,468	94.73	9,801,640
Georgia	120,715	65.83	7,946,663	193,271	88.45	17,093,854
Florida	44,695	61.26	2,737,863	14,129	95.64	1,351,258
Alabama	147,769	53.10	7,846,319	155,339	69.89	10,856,028
Mississippi	242,431	52.38	12,699,325	197,611	72.59	14,344,528
Louisiana	183,086	47.56	8,708,344	132,231	89.22	11,797,399
Texas	1,291,458	30.12	38,901,293	407,161	51.24	20,861,205
Arkansas	241,259	46.81	11,293,408	144,240	66.23	9,552,956
Tennessee	289,463	56.46	16,344,131	172,549	71.11	12,270,225
West Virginia	167,389	63.63	10,651,014	10,297	70.67	727,712
Kentucky	366,746	61.03	22,384,304	140,222	73.04	10,242,379
Ohio	793,992	79.86	63,404,695	15,515	75.65	1,173,720
Michigan	542,589	79.30	43,028,264	2,713	61.39	166,549
Indiana	649,058	73.68	47,824,869	54,669	76.47	4,180,663
Illinois	1,077,188	78.52	84,583,390	107,699	83.89	9,034,795
Wisconsin	519,738	78.85	40,981,046	4,749	67.61	321,100
Minnesota	661,963	71.37	47,242,315	8,083	71.22	575,650
Iowa	1,144,570	69.69	79,760,061	45,914	74.06	3,400,365
Missouri	809,968	60.77	49,218,675	209,163	71.56	14,967,730
Kansas	880,715	56.93	50,139,464	93,580	65.91	6,168,149
Nebraska	772,231	55.66	42,983,085	47,659	67.44	3,214,225
South Dakota	449,114	53.90	24,208,102	6,825	57.53	392,646
North Dakota	358,770	70.07	25,139,076	7,032	80.64	567,056
Montana	246,570	29.41	7,251,264	3,424	38.49	131,784
Wyoming	113,444	28.94	3,282,736	1,481	52.86	78,292
Colorado	205,336	38.49	7,904,363	9,284	55.46	514,917
New Mexico	118,298	22.69	2,683,832	4,900	38.81	190,182
Arizona	111,001	23.48	2,606,176	3,738	43.55	162,807
Utah	104,266	37.60	3,920,265	2,024	45.54	92,180
Nevada	76,011	34.94	2,655,629	2,152	44.51	95,777
Idaho	148,279	33.64	4,988,597	1,536	46.97	72,145
Washington	216,988	60.77	13,187,130	2,251	69.72	156,939
Oregon	233,943	50.63	11,843,718	7,086	52.32	370,767
California	370,716	60.66	22,485,881	67,708	72.02	4,876,600
Oklahoma	325,129	47.07	15,302,858	59,403	65.33	3,880,789
Indian Territory	186,483	34.20	6,377,720	40,583	59.22	2,403,204
United States	16,557,373	62.25	1,030,705,959	2,728,088	72.49	197,753,327

Imports of animals not subject to quarantine through seacoast ports in 1902.

From—	Horses.	Ponies.	Mules.	Zebra.	Water buffaloes.	Bears.	Monkey.	Dogs.
Europe	2,206	58	11	1				
Bermuda	13							
Porto Rico	1	2						
Cuba	11							
Mexico	4		1					
South America	1							
Algiers			1					
Manila	2				4			
China	3							
Canada	42		1					2
New Zealand						4		
Ceylon							1	
Total	2,283	60	14	1	4	4	1	2

Range of prices for horses in Omaha, monthly, 1898–1902.

Date.	Drafts.		General purposes.		Southern.		Western.		Drivers.		Carriage teams.	
	Low.	High.	Low.	High.	Low.	High.	Low.	High.	Low.	High.	Low.	High.
1898.												
January	$75.00	$100.00	$30.00	$55.00	$20.00	$45.00	$13.00	$20.00	$40.00	$90.00	$150.00	$300.00
February	75.00	100.00	35.00	60.00	20.00	45.00	15.00	20.00	45.00	100.00	150.00	300.00
March	85.00	110.00	40.00	60.00	20.00	40.00	12.00	20.00	50.00	110.00	150.00	[illegible]
April	90.00	115.00	40.00	60.00	20.00	40.00	12.00	20.00	60.00	125.00	150.00	350.00
May	85.00	110.00	40.00	60.00	20.00	40.00	14.00	25.00	60.00	150.00	150.00	400.00
June	85.00	110.00	35.00	55.00	15.00	35.00	15.00	30.00	50.00	125.00	150.00	350.00
July	90.00	115.00	30.00	50.00	15.00	35.00	15.00	35.00	50.00	125.00	125.00	300.00
August	100.00	125.00	30.00	50.00	15.00	35.00	15.00	40.00	40.00	125.00	125.00	300.00
September	100.00	125.00	35.00	55.00	10.00	35.00	15.00	45.00	40.00	125.00	150.00	300.00
October	90.00	125.00	35.00	55.00	10.00	35.00	15.00	45.00	35.00	100.00	150.00	300.00
November	100.00	125.00	35.00	60.00	15.00	35.00	15.00	40.00	35.00	100.00	150.00	350.00
December	70.00	90.00	35.00	50.00	20.00	40.00	12.00	20.00	35.00	100.00	150.00	300.00
1899.												
January	75.00	115.00	35.00	60.00	20.00	45.00	10.00	20.00	95.00	225.00	200.00	[illegible]
February	80.00	120.00	35.00	65.00	20.00	50.00	10.00	20.00	95.00	225.00	200.00	[illegible]
March	90.00	125.00	40.00	65.00	20.00	50.00	10.00	20.00	95.00	225.00	200.00	300.00
April	90.00	140.00	40.00	70.00	20.00	50.00	10.00	20.00	95.00	225.00	200.00	300.00
May	100.00	150.00	40.00	70.00	20.00	45.00	12.50	22.50	90.00	325.00	300.00	450.00
June	90.00	140.00	40.00	65.00	15.00	45.00	12.50	25.00	90.00	325.00	300.00	450.00
July	90.00	140.00	40.00	60.00	15.00	45.00	15.00	27.50	75.00	200.00	200.00	325.00
August	90.00	140.00	40.00	60.00	15.00	45.00	17.50	30.00	75.00	220.00	210.00	420.00
September	90.00	140.00	40.00	60.00	15.00	45.00	20.00	40.00	85.00	175.00	215.00	360.00
October	100.00	160.00	40.00	65.00	20.00	45.00	30.00	77.50	90.00	215.00	175.00	[illegible]
November	90.00	150.00	40.00	60.00	20.00	50.00	30.00	65.00	90.00	325.00	230.00	370.00
December	100.00	160.00	35.00	60.00	20.00	55.00	29.00	45.00	90.00	300.00	200.00	375.00
1900.												
January	75.00	135.00	55.00	85.00	20.00	45.00	10.00	20.00	95.00	225.00	200.00	300.00
February	80.00	150.00	55.00	90.00	20.00	50.00	10.00	20.00	95.00	225.00	200.00	300.00
March	90.00	165.00	55.00	90.00	20.00	50.00	10.00	20.00	95.00	225.00	200.00	300.00
April	90.00	175.00	60.00	100.00	20.00	50.00	10.00	20.00	95.00	225.00	200.00	350.00
May	100.00	150.00	65.00	105.00	20.00	45.00	12.50	22.50	90.00	325.00	300.00	450.00
June	90.00	140.00	40.00	65.00	15.00	45.00	12.50	25.00	90.00	325.00	300.00	450.00
July	90.00	140.00	40.00	60.00	15.00	45.00	15.00	27.50	75.00	200.00	200.00	325.00
August	90.00	140.00	40.00	60.00	15.00	45.00	17.50	30.00	75.00	220.00	210.00	420.00
September	90.00	140.00	40.00	60.00	15.00	45.00	20.00	40.00	85.00	175.00	215.00	360.00
October	100.00	160.00	40.00	65.00	20.00	45.00	30.00	77.50	90.00	215.00	175.00	435.00
November	90.00	150.00	40.00	60.00	20.00	50.00	12.50	45.00	90.00	325.00	230.00	370.00
December	100.00	160.00	35.00	60.00	20.00	55.00	12.50	40.00	90.00	300.00	200.00	375.00
1901.												
January	90.00	150.00	55.00	85.00	25.00	60.00	10.00	30.00	95.00	225.00	200.00	300.00
February	95.00	160.00	55.00	90.00	25.00	60.00	10.00	30.00	95.00	225.00	200.00	300.00
March	90.00	165.00	55.00	90.00	20.00	55.00	10.00	30.00	95.00	225.00	200.00	300.00
April	90.00	200.00	60.00	100.00	20.00	50.00	10.00	35.00	95.00	225.00	200.00	400.00
May	100.00	200.00	65.00	105.00	20.00	45.00	12.50	35.00	90.00	325.00	300.00	450.00
June	90.00	150.00	40.00	80.00	20.00	45.00	12.50	40.00	90.00	325.00	300.00	450.00
July	90.00	160.00	40.00	80.00	15.00	45.00	10.00	45.00	75.00	200.00	200.00	400.00
August	90.00	160.00	40.00	80.00	15.00	45.00	5.00	40.00	75.00	220.00	210.00	420.00
September	90.00	175.00	40.00	80.00	15.00	45.00	5.00	50.00	85.00	175.00	215.00	360.00
October	100.00	175.00	40.00	80.00	20.00	45.00	10.00	60.00	90.00	215.00	175.00	[illegible]
November	90.00	160.00	40.00	80.00	20.00	50.00	10.00	45.00	90.00	325.00	230.00	370.00
December	100.00	160.00	45.00	85.00	20.00	55.00	12.50	40.00	90.00	300.00	200.00	375.00
1902.												
January	90.00	175.00	55.00	85.00	35.00	80.00	10.00	50.00	95.00	225.00	200.00	350.00
February	95.00	185.00	60.00	100.00	35.00	80.00	10.00	50.00	95.00	225.00	200.00	350.00
March	100.00	200.00	60.00	100.00	35.00	80.00	10.00	50.00	95.00	225.00	200.00	350.00
April	100.00	225.00	60.00	110.00	30.00	65.00	10.00	50.00	100.00	250.00	200.00	500.00
May	100.00	250.00	65.00	105.00	25.00	60.00	12.50	60.00	90.00	325.00	300.00	500.00
June	90.00	200.00	60.00	90.00	20.00	45.00	12.50	60.00	90.00	325.00	300.00	450.00
July	90.00	175.00	40.00	80.00	15.00	45.00	10.00	65.00	75.00	200.00	200.00	[illegible]
August	90.00	175.00	40.00	80.00	15.00	45.00	10.00	80.00	75.00	220.00	210.00	[illegible]
September	90.00	175.00	40.00	80.00	15.00	45.00	10.00	100.00	85.00	175.00	215.00	360.00
October	100.00	175.00	40.00	80.00	20.00	45.00	10.00	100.00	90.00	215.00	175.00	435.00
November	90.00	160.00	40.00	80.00	20.00	65.00	10.00	80.00	90.00	325.00	230.00	370.00
December	100.00	185.00	45.00	85.00	20.00	70.00	12.50	60.00	90.00	300.00	200.00	375.00

CATTLE AND DAIRY PRODUCTS.

Numbers and values of milch cows and other cattle, 1880 to 1903.

January 1—	Milch cows.		Other cattle.	
	Number.	Value.	Number.	Value.
1880	12,027,000	$279,899,420	21,231,000	$341,761,154
1881	12,368,653	296,277,060	20,937,702	362,861,509
1882	12,611,632	326,489,310	23,280,238	463,069,499
1883	13,125,685	396,575,405	28,046,077	611,549,109
1884	13,501,206	423,486,649	29,046,101	683,229,054
1885	13,904,722	412,903,093	29,866,573	694,382,913
1886	14,235,388	389,985,523	31,275,242	661,956,274
1887	14,522,083	378,789,589	33,511,750	663,137,926
1888	14,856,414	366,252,173	34,378,363	611,750,520
1889	15,298,625	366,226,376	35,032,417	597,236,812
1890	15,952,883	352,152,133	36,849,024	560,625,137
1891	16,019,591	346,397,900	36,875,648	544,127,908
1892	16,416,351	351,378,132	37,651,239	570,749,155
1893	16,424,087	357,299,785	35,954,196	547,882,204
1894	16,487,400	358,998,661	36,608,168	536,789,747
1895	16,504,629	362,601,729	34,364,216	482,999,129
1896	16,137,586	363,955,545	32,085,409	508,928,416
1897	15,941,727	369,239,993	30,508,408	507,929,421
1898	15,840,886	434,813,826	29,264,197	612,296,634
1899	15,990,115	474,233,925	27,994,225	637,931,135
1900	16,292,360	514,812,106	27,610,054	689,486,260
1901	16,833,657	505,093,077	45,500,213	906,644,003
1902	16,696,802	488,130,324	44,727,797	839,126,073
1903	17,105,227	516,711,914	44,659,206	824,054,902

Imports and exports of milch cows and other cattle, 1892 to 1902.

Year ended June 30—	Imports.			Exports.		
	Number.	Value.	Average price.	Number.	Value.	Average price.
1892	2,168	$47,466	$21.89	394,607	$35,099,095	$88.95
1893	3,293	45,682	13.87	287,094	26,032,428	90.68
1894	1,592	18,704	11.75	359,278	33,461,922	93.14
1895	149,781	765,853	5.11	331,722	30,603,796	92.26
1896	217,826	1,509,856	6.93	372,461	34,560,672	92.79
1897	328,977	2,589,857	7.87	392,190	36,357,451	92.70
1898	291,589	2,913,223	9.99	439,255	37,827,500	86.12
1899	199,752	2,320,362	11.62	389,490	30,516,833	78.35
1900	181,006	2,257,694	12.47	397,286	30,635,153	77.11
1901	146,022	1,931,433	13.23	459,218	37,566,980	81.81
1902	96,027	1,608,722	16.75	392,884	29,902,212	76.11

Tuberculin tests of pure-bred cattle for importation into the United States in 1902.

GREAT BRITAIN.

Breed.	Passed.	Rejected.	Breed.	Passed.	Rejected.
Shorthorn	84	27	Hereford	294	15
Jersey	191	1	Galloway	1	
Aberdeen Angus	186	73	Dexter Kerry	15	
Ayrshire	25	8			
Guernsey	79	11	Total	928	139
Red poll	53	4			

CANADA.

Breed.	Passed.	Rejected.	Breed.	Passed.	Rejected.
Aberdeen Angus	3		Ayrshire	17	6
Jersey	24		Durham	4	
Hereford	26	1	Grades	84	
Shorthorn	188	20			
Holstein	9		Total	355	27

Number, average price, and total value of cattle in the United States on January 1, 1903.

States and Territories.	Milch cows.			Other cattle.		
	Number.	Average price per head.	Value.	Number.	Average price per head.	Value.
Maine	183,581	$31.59	$5,799,324	123,677	$17.46	$2,158,855
New Hampshire	123,667	32.50	4,019,178	101,193	18.21	1,842,674
Vermont	282,546	28.18	7,962,146	225,893	13.34	3,012,775
Massachusetts	181,481	39.00	7,077,759	93,400	16.34	1,526,566
Rhode Island	24,498	38.30	938,273	10,875	17.53	190,647
Connecticut	128,284	39.25	5,035,147	88,377	20.33	1,796,288
New York	1,576,503	35.23	55,619,026	955,468	16.24	15,512,188
New Jersey	172,347	39.69	6,840,452	82,890	19.82	1,643,149
Pennsylvania	1,044,625	31.54	32,947,472	823,143	16.56	13,630,431
Delaware	34,435	32.86	1,131,531	21,606	19.80	427,850
Maryland	145,992	29.61	4,322,823	133,992	18.56	2,486,244
Virginia	257,859	25.33	6,531,568	449,679	17.44	7,812,844
North Carolina	201,160	19.84	3,990,923	367,772	9.8[illegible]	3,[illegible]1[illegible]2
South Carolina	109,715	22.92	2,514,668	171,459	9.76	1,673,542
Georgia	274,604	21.94	6,024,812	623,033	9.32	5,806,173
Florida	82,047	21.60	1,772,215	544,298	8.62	4,691,361
Alabama	234,792	18.62	4,371,827	399,319	7.45	2,975,843
Mississippi	264,030	19.43	5,130,103	436,219	9.02	3,935,174
Louisiana	164,706	24.81	4,086,356	421,818	10.99	4,635,570
Texas	813,852	22.26	18,116,346	8,007,910	13.70	109,698,754
Arkansas	272,629	19.93	5,433,496	455,305	9.05	4,122,422
Tennessee	282,557	22.97	6,490,334	442,405	12.47	5,514,798
West Virginia	178,628	28.44	5,080,180	359,593	20.19	7,259,350
Kentucky	298,570	26.69	7,968,833	508,918	19.07	9,706,192
Ohio	767,516	33.46	25,681,085	1,190,024	22.24	26,467,081
Michigan	534,605	34.52	18,454,565	736,441	17.99	13,246,509
Indiana	558,702	32.11	17,939,921	913,860	22.81	20,844,059
Illinois	985,769	35.32	34,817,361	1,700,716	26.49	45,054,861
Wisconsin	1,032,955	31.01	32,031,935	1,148,698	15.54	17,845,142
Minnesota	788,884	28.45	22,443,750	1,002,668	13.35	13,388,324
Iowa	1,390,912	30.03	41,769,087	3,574,012	23.10	82,544,665
Missouri	575,658	28.35	16,319,904	1,405,081	21.54	30,263,330
Kansas	706,309	28.35	20,023,860	2,741,236	22.53	61,747,445
Nebraska	618,891	28.33	17,533,267	2,403,999	19.71	47,384,787
South Dakota	378,679	28.10	10,640,880	1,456,291	20.49	29,836,195
North Dakota	166,665	32.87	5,478,279	570,956	22.40	12,788,267
Montana	52,380	40.12	2,101,486	1,048,559	27.24	28,560,233
Wyoming	19,587	38.46	753,316	796,060	23.31	18,553,928
Colorado	120,569	33.24	4,007,714	1,286,300	19.01	24,491,409
New Mexico	18,657	34.84	650,010	872,471	17.45	15,220,959
Arizona	18,486	37.58	694,704	551,328	16.56	9,129,446
Utah	68,808	32.82	2,258,279	254,326	19.65	4,997,689
Nevada	16,010	37.33	597,653	364,165	22.35	8,138,873
Idaho	54,082	35.42	1,915,584	362,089	21.81	7,898,899
Washington	141,701	38.55	5,462,574	309,909	22.24	6,893,804
Oregon	129,713	35.63	4,621,674	570,044	20.61	11,750,484
California	337,482	40.43	13,644,397	1,111,767	24.51	27,244,079
Oklahoma	183,122	26.76	4,900,345	1,312,620	19.01	24,947,783
Indian Territory	105,674	26.17	2,765,489	1,187,399	16.59	19,697,759
United States	17,105,227	30.21	516,711,914	44,659,206	18.45	824,054,902

Inspection of Vessels and Export Animals.

The number of certificates of inspection issued for American cattle exported to Europe in 1902 was 1,102; the number of clearances of vessels carrying inspected live stock was 837. The figures show a falling off in the exports of American animals, there being 91,336 cattle, 16,710 sheep, and 13,985 horses fewer than during the previous year. The number of Canadian cattle and sheep exported from United States ports was increased. All of the animals in the following table were exported to Great Britain with the exception of 301 cattle, 200 sheep, and 412 horses to Belgium, 198 sheep to France, and 124 horses to Germany.

Number of inspections, etc., of American and Canadian animals, fiscal year 1902.

Kind of animal.	American.				Canadian.		
	Inspections.	Rejected.	Tagged.	Exported.	Inspected.	Rejected.	Exported.
Cattle	584,040	1,491	304,441	[a]293,386	72,726	47	72,679
Sheep	401,132	266		[b]211,224	52,445	74	52,371
Horses	19,990	86	11,272	[c]10,967	337	2	335

[a] 7,904 via Canada. [b] 280 via Canada. [c] 80 via Canada.

Wholesale prices of cattle per 100 pounds, 1898 to 1902.

Date.	Chicago.		Cincinnati.		St. Louis.		Omaha.	
	Inferior to prime.		Fair to medium.		Good to choice native steers.		Native beeves.	
	Low.	High.	Low.	High.	Low.	High.	Low.	High.
1898.								
January	$2.25	$5.60	$3.25	$4.00	$4.25	$5.15	$3.50	$4.75
February	2.40	5.65	3.40	4.00	4.10	5.15	3.50	4.90
March	2.60	5.85	3.40	4.00	4.25	5.30	3.50	5.20
April	2.50	5.75	3.40	4.25	4.10	5.40	3.50	5.00
May	2.70	5.35	3.25	4.15	4.00	5.10	3.50	4.85
June	2.70	5.40	3.10	4.00	4.35	5.15	3.40	5.50
July	2.70	5.55	3.25	4.15	4.35	5.50	3.50	5.40
August	2.70	5.75	3.25	4.25	4.00	5.65	3.75	5.50
September	2.70	5.85	3.25	4.25	4.25	5.65	3.50	5.40
October	2.60	5.90	3.25	4.15	4.50	5.50	3.25	5.35
November	2.50	5.75	3.15	4.10	4.00	5.30	3.25	5.25
December	2.50	6.25	3.25	4.00	4.00	5.40	3.00	5.80
1899.					*1,000 to 1,200 lbs.*			
January	2.00	6.30	3.25	4.00	4.25	5.80	3.75	5.50
February	2.50	6.30	3.40	4.00	4.10	5.75	3.75	5.50
March	2.70	5.90	3.40	4.35	4.00	5.00	3.85	5.40
April	2.70	5.90	3.35	4.25	4.10	5.25	4.00	5.50
May	2.70	5.65	3.50	4.50	4.00	5.10	4.25	5.50
June	2.80	5.70	3.50	4.50	4.00	5.40	4.00	5.50
July	2.80	6.00	3.50	4.15	4.10	5.50	4.00	5.80
August	2.80	6.65	3.75	4.35	4.00	5.85	4.00	6.25
September	2.80	6.90	3.25	4.15	4.10	5.90	4.00	6.15
October	2,80	7.01	3.00	4.35	4.00	5.80	4.25	6.30
November	2.80	6.90	3.35	4.25	4.00	5.70	4.50	6.05
December	2.80	7.00	3.40	4.40	4.00	6.00	4.00	7.25
1900.					*1,000 to 1,400 lbs.*			
January	2.25	6.60	3.25	4.25	4.20	6.00	4.00	6.25
February	2.25	6.10	3.35	4.35	4.20	5.75	3.75	5.55
March	2.25	6.05	3.40	4.50	4.55	5.50	3.75	5.20
April	2.25	6.00	3.75	4.65	4.50	5.75	3.75	5.25
May	2.50	5.80	4.10	4.70	4.50	5.50	4.00	5.30
June	2.25	5.90	4.00	4.60	4.40	5.60	4.00	5.40
July	2.25	5.75	3.75	4.50	4.25	5.70	4.00	5.50
August	2.25	6.10	3.65	4.60	4.25	6.00	4.00	5.80
September	2.25	6.00	3.75	4.60	4.20	5.85	3.75	5.70
October	1.75	6.00	3.10	4.40	4.10	5.85	3.75	5.50
November	1.75	6.00	3.00	4.15	4.00	5.85	3.75	5.50
December	1.75	....	3.00	4.25	4.10	6.50	3.50	7.50
1901.								
January	2.70	6.15	3.25	4.45	4.75	5.60	3.50	5.35
February	2.70	6.10	3.10	4.30	4.75	5.65	3.50	5.30
March	2.70	6.25	3.15	4.90	4.75	5.60	3.75	5.40
April	2.70	6.10	3.35	4.75	4.75	5.85	3.75	5.45
May	2.70	6.10	3.60	5.05	4.80	6.00	3.75	5.60
June	2.70	6.55	3.75	4.50	5.00	6.00	4.00	5.90
July	2.20	6.55	3.25	4.25	4.75	6.35	4.00	5.75
August	2.20	6.35	2.90	4.50	5.00	6.35	4.00	5.90
September	2.20	6.60	3.10	4.35	5.00	6.40	4.00	6.25
October	2.20	6.85	3.00	4.25	5.50	6.75	4.00	6.40
November	2.10	6.90	3.00	4.15	5.50	7.00	4.00	7.25
December	2.10	7.00	3.15	4.60	5.50	8.25	3.50	6.85
1902.								
January	2.20	7.75	3.75	4.65	6.10	7.00	3.40	6.55
February	2.25	7.35	3.65	4.75	6.35	6.50	3.50	6.25
March	2.35	7.35	3.75	5.25	6.40	6.75	4.00	6.70
April	2.35	7.50	4.25	5.40	6.95	7.10	4.50	7.00
May	2.50	7.70	4.10	5.35	6.90	7.50	4.35	7.40
June	2.35	8.50	3.25	5.25	7.50	8.00	4.25	7.85
July	2.25	8.85	3.15	5.25	7.50	8,35	5.00	8.15
August	2.40	9.00	3.25	5.25	7.40	8.75	5.00	8.15
September	2.25	8.85	3.00	4.40	6.60	8.00	4.15	7.85
October	1.90	8.75	2.90	4.25	6.35	7.10	4.50	7.25
November	2.00	7.40	3.00	4.15	5.15	7.25	3.20	6.00
December	2.00	14.50	3.00	4.40	5.25	6.00	3.00	6.25

Wholesale prices of butter per pound in leading cities of the United States, 1898–1902.

Date.	New York. Creamery extra.		Cincinnati. Creamery.		Chicago. Creamery firsts.		Elgin. Creamery extra.	
	Low.	High.	Low.	High.	Low.	High.	Low.	High.
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
1898.								
January	20	22	16	20	16	21	19	21
February	20	20½	16	18	16	19½	19	20
March	19	20½	16	18	16	20	18½	19½
April	17	22	14	18	15	21	16½	20
May	15	17	14	16	14	16½	15	16½
June	16	17	13	15	14½	16	15½	16
July	16½	18½	14	15	14½	17½	16	17½
August	18½	19	16	17	16	18½	18	18½
September	18½	21	16	18	15½	20	18	20
October	20½	23	16	18	17	22	20	22
November	23	23½	18	19	19	22	22	22
December	20	23½	17	18	16	22	20½	22
1899.								
January	19	21	16	18	14	20½	18	20½
February	19	25	17	20	14	21½	20	22
March	20	22	19	20	17	21	20	20½
April	17	21½	18	19	14	21	17	20½
May	16½	19	16	17	14	18½	16	18
June	18	18½	17	18	16	18	18	18
July	17½	18½	16½	18	15½	18	17½	18
August	17½	21	16½	20	15½	20	18	20
September	20½	23	18	20	17½	22½	21	22½
October	23½	24	18	20	18	23	23½	23½
November	24	27	18	24	19	26	24½	26½
December	26½	28	21	24	21	27	26	27
1900.								
January	24	30	21	27	22	29	24	29
February	24	26	21	22	21	24½	24	24
March	23½	26	21	22	20	24½	24	24½
April	17½	23	16	20	15½	22	18	22½
May	18½	19½	16	18	16	19½	19½	19½
June	....	....	16	18	16½	19½	18	19½
July	19	20	17	18	17	19	19	19
August	18½	21	17	20	17	21	19½	21½
September	21	22	19	21	17½	21½	20½	21½
October	20½	22½	18	21	17	22	20½	22
November	22½	27	20	25	18	25½	22	26
December	25	26	23	24	20	24	24½	25
1901.								
January	21	25	18	24	15	23	21	24½
February	22	24	18	22	16	23	21	23½
March	22	23½	19	21	17	23	21½	23½
April	18	21	17	20	16	20½	20	21½
May	18	18	17	18	15½	18½	18½	18½
June	19	19½	17	19	16	19	18½	19
July	18	19	17	19	16	20	19	20
August	20	21	17	19	16	20½	20	21
September	20	22½	18	20	16	21	20	21
October	21	22½	20	22	17	22	21½	22
November	22½	25½	22	23	18	24½	22	24½
December	24	25½	22	23	20	24½	24½	24½
1902.								
January	23	26	22	23	20	24	24	24½
February	26	30	22	26	20	29	25½	29
March	27	30	23	24	22	28	27	28
April	22	33	23	27	18	31	22	30
May	22¼	25	19	20	19	23	22	22
June	21½	22½	19	20	18½	22	21½	22
July	20½	21¾	18	21	18½	21½	21	21½
August	19	20½	17	19	16	20	19	20
September	19½	23	17	21½	17½	22½	19	22½
October	22½	25	20½	22½	19	24½	22½	24½
November	25	28½	21½	25	21½	27½	24½	27
December	28	30	25	27	23	28½	28	29

Wholesale prices of cheese per pound in leading cities of the United States, 1898–1902.

Date.	New York.		Cincinnati.		Chicago.		St. Louis.	
	September; colored.		Factory.		Full cream.		Full cream.	
	Low.	High.	Low.	High.	Low.	High.	Low.	High.
1898.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	8½	8¾	9	9½	3	9	10	10
February	8½	8⅝	9	9½	3	9¼	10	10
March	8	8½	8½	9½	3	9¼	10	10
April	8	9	8½	9	3	9¼	9	10
May	6⅝	8⅜	7	9	5	9¼	9	9½
June	6¾	7¼	7	7½	7¼	7¾	8	8¼
July	7	7¾	7	8	7¾	8¼	8¼	8¼
August	7	7⅝	7½	9	8	8½	8¼	8¾
September	7¼	8½	7½	9	8	8½	8¾	10
October	8¼	8¾	8½	9½	8	9½	10	10
November	8½	9¾	9	9½	9	10½	10	10
December	9¾	10½	10	11	10	11	10	10½
1899.								
January	10½	10½	10½	11½	9½	11	10½	11
February	10½	11	10½	11½	9½	11	11	11
March	11	12¼	11	12¼	9¾	12	11	11½
April	12	12¼	11½	12¼	11	12¼	12½	12½
May	8½	12	9½	12	9½	11¼	10½	12½
June	7½	8¾	8	10	8	9½	9	9¾
July	8	9½	8½	9½	8¼	9	9¼	10¼
August	9¼	11¼	9	11	8¾	10	10¼	10½
September	11¼	11¾	10¾	12	10	11¾	11¾	12½
October	12	12¾	12	12½	11¼	12¼	13	13
November	12½	12¾	12½	12½	11	12½	12	13
December	12¾	13	12	12½	11	13	12½	12½
1900.					Twins.			
January	12¾	13	12	12½	8	12½	12½	12½
February	12¾	13¼	12	12½	8½	12½	12½	12½
March	13¼	13½	12	12½	9	12½	12½	12½
April	11	13½	12	12½	8½	12½	12	12½
May	9¼	11	9	11½	8½	11½	10	11¾
June	9¼	10	8½	9	7	9¾	10	10½
July	9	9½	8½	9½	8	10¼	10½	10¾
August	9¼	10⅝	8½	10½	8	10¾	10¾	12
September	12	12¼	10	10½	9½	11¼	10¼	11⅜
October	10⅝	11⅜	10½	11½	10	11½	11¾	12
November	10¾	11	10¾	11	9¾	10¾	11½	11¾
December	11	11½	10¾	11	9¾	10½	11½	11½
1901.								
January	11¼	12	11	12	10½	11½	11½	11½
February	12	12½	11½	12	11½	11½	11	11½
March	12	12½	11½	12	11	11¾	12	12
April	11½	12½	11	12	11½	11¾	11	12
May	8½	9½	8½	12	10½	11¾	10	11
June	9	9¾	8½	9½	9	10½	10	10¾
July	9	9½	8½	9½	9½	10¼	10	11¼
August	9⅝	9⅞	9	10	10	10¾	11	11½
September	9½	10¼	9½	10	10	10¾	10½	11½
October	10¼	10¾	9½	10½	10	10¾	10½	11½
November	10¼	10¾	10	10½	9¾	10¼	10¾	11¼
December	10	11¼	10	10½	10	10¾	10¾	11¼
1902.								
January	11¼	11¾	10½	11	9¾	10½	10¾	11½
February	11½	12½	10½	11½	10	10¾	12½	13
March	12¼	13¼	11	11½	10½	12	13	14
April	13	13¼	11	11½	11	12¾	13¾	14½
May	10½	13	11½	12½	10¾	12¾	12¾	14
June	9½	9¾	10½	12½	9½	11	11	11½
July	9¾	10¼	10½	10½	9¾	10¼	11½	11½
August	9½	10½	10½	10½	10	10½	11½	11¾
September	10⅜	12	10½	11	10	10½	11¼	12
October	12	12½	11	12½	10½	11	11¾	12½
November	12½	13	12	12½	10½	11¼	12¾	13½
December	13	13½	12	13	11	13	13¾	14

SHEEP AND WOOL.

Number and value of sheep, 1880–1903.

January 1—	Sheep.		January 1—	Sheep.	
	Number.	Value.		Number.	Value.
1880	40,765,900	$90,230,537	1892	44,938,365	$116,121,290
1881	43,576,899	104,070,759	1893	47,273,553	125,909,264
1882	45,016,224	106,594,954	1894	45,048,017	89,186,110
1883	49,237,291	124,365,835	1895	42,294,064	66,685,767
1884	50,626,626	119,902,706	1896	38,298,783	65,167,735
1885	50,360,243	107,960,650	1897	36,818,643	67,020,942
1886	48,322,331	92,443,867	1898	37,656,960	92,721,133
1887	44,759,314	89,872,839	1899	39,114,453	107,697,530
1888	43,544,755	89,279,926	1900	41,883,065	122,665,913
1889	42,599,079	90,640,369	1901	59,756,718	178,072,476
1890	44,336,072	100,659,761	1902	62,039,091	164,446,091
1891	43,431,136	108,397,447	1903	63,964,876	168,315,750

Number, average price, and total value of sheep in the United States on January 1, 1903.

States and Territories.	Number.	Average price per head.	Value.	States and Territories.	Number.	Average price per head.	Value.
Maine	397,446	$2.92	$1,158,793	Indiana	1,355,436	$3.44	$4,667,308
New Hampshire	89,788	2.78	249,647	Illinois	988,171	3.84	3,792,909
Vermont	273,876	3.12	853,700	Wisconsin	1,473,197	3.04	4,476,457
Massachusetts	48,231	4.57	220,537	Minnesota	564,107	2.93	1,650,498
Rhode Island	10,393	3.89	40,429	Iowa	898,040	3.58	3,211,571
Connecticut	34,600	4.69	162,191	Missouri	810,543	2.99	2,429,290
New York	1,397,845	3.73	5,219,273	Kansas	271,360	3.00	813,891
New Jersey	47,037	4.24	199,597	Nebraska	536,239	2.76	1,481,950
Pennsylvania	1,133,437	3.40	3,850,625	South Dakota	918,665	2.86	2,621,718
Delaware	12,067	3.82	46,150	North Dakota	827,781	2.98	2,462,979
Maryland	166,902	3.58	597,342	Montana	8,932,311	2.48	22,137,839
Virginia	596,160	2.89	1,725,465	Wyoming	5,826,150	2.46	14,306,695
North Carolina	220,682	1.79	395,749	Colorado	2,337,365	2.21	5,156,461
South Carolina	61,291	2.02	123,752	New Mexico	5,677,156	1.72	9,754,490
Georgia	297,484	1.80	536,186	Arizona	1,099,180	2.54	2,794,334
Florida	99,067	1.98	196,253	Utah	3,570,670	2.40	8,561,986
Alabama	212,797	1.55	330,558	Nevada	1,034,826	2.89	2,991,166
Mississippi	199,456	1.60	319,290	Idaho	4,541,815	2.56	11,612,513
Louisiana	178,439	1.83	326,026	Washington	1,146,583	2.90	3,329,768
Texas	1,736,603	2.04	3,541,803	Oregon	3,569,754	2.54	9,052,183
Arkansas	177,414	1.62	287,039	California	2,365,884	2.92	6,915,716
Tennessee	326,498	2.19	714,313	Oklahoma	67,623	2.63	177,923
West Virginia	705,382	2.73	1,926,115	Indian Territory	26,340	2.76	72,715
Kentucky	790,966	2.62	2,072,726				
Ohio	3,447,786	3.12	10,743,991	United States	63,964,876	2.63	168,315,750
Michigan	2,465,221	3.25	8,014,680				

Imports and exports of sheep, with average prices, 1892–1902.

Year ended June 30—	Imports.			Exports.		
	Number.	Value.	Average price.	Number.	Value.	Average price.
1892	380,814	$1,440,530	$3.78	46,960	$161,105	$3.43
1893	459,484	1,682,977	3.66	37,260	126,394	3.39
1894	242,568	788,181	3.25	132,370	832,763	6.29
1895	291,461	682,618	2.34	405,748	2,630,686	6.48
1896	322,692	853,530	2.65	491,565	3,076,384	6.26
1897	405,633	1,019,668	2.51	244,120	1,531,645	6.27
1898	392,314	1,106,322	2.82	199,690	1,213,886	6.08
1899	345,911	1,200,081	3.47	143,286	853,555	5.96
1900	381,792	1,365,026	3.58	125,772	733,477	5.83
1901	331,488	1,236,277	3.73	297,925	1,933,000	6.49
1902	266,953	956,711	3.58	358,720	1,940,060	5.41

Prices of sheep per 100 pounds in leading cities of the United States, 1898–1902.

Date.	Chicago.		Cincinnati.		St. Louis.		Omaha.	
	Inferior to choice.		Good to extra.		Good to choice natives.		Native.	
	Low.	High.	Low.	High.	Low.	High.	Low.	High.
1898.								
January	$3.10	$4.80	$4.00	$4.65	$3.00	$4.80	$3.00	$5.25
February	3.50	4.75	4.00	4.65	3.50	4.55	3.00	4.50
March	3.25	4.75	3.75	4.75	3.90	4.35	2.75	4.35
April	3.25	4.85	3.50	4.65	3.20	5.00	3.00	4.70
May	3.00	4.65	3.35	4.00	3.50	4.50	3.50	4.60
June	3.10	5.25	3.25	4.25	4.10	4.85	3.00	5.00
July	3.25	5.25	3.15	4.15	3.50	4.75	3.25	5.00
August	3.00	4.85	3.25	4.25	3.50	4.00	3.50	4.85
September	3.00	4.75	3.10	4.25	3.75	4.35	3.00	4.25
October	3.00	4.70	3.25	4.25	4.00	4.60	3.00	4.50
November	2.50	4.70	3.15	4.10	3.00	4.35	2.75	4.50
December	2.50	4.55	3.25	4.00	3.50	4.25	2.75	4.65
1899.								
January	2.50	4.30	3.10	4.00	3.50	4.25	3.25	4.75
February	2.80	4.55	3.50	4.25	3.50	4.50	3.25	4.50
March	2.90	4.80	3.40	4.25	3.75	4.75	3.25	5.00
April	3.25	5.10	4.00	5.00	4.00	5.15	3.50	5.00
May	3.65	5.65	4.00	5.00	4.25	5.60	3.50	5.50
June	3.25	5.55	3.40	4.35	3.75	5.35	3.00	5.25
July	3.00	5.40	3.00	4.25	4.00	4.75	3.00	4.75
August	2.75	5.15	2.85	4.35	3.50	4.10	3.50	4.50
September	2.75	4.70	3.00	4.00	3.50	4.25	3.25	4.40
October	2.90	4.40	3.00	4.85	3.00	4.20	3.00	4.40
November	2.75	4.50	3.00	3.90	3.10	4.50	3.00	4.60
December	2.75	4.80	3.00	3.90	3.25	5.10	2.75	4.60
1900.								
January	2.60	5.25	3.35	4.75	4.00	5.25	3.25	5.25
February	2.75	5.90	4.00	5.75	4.75	5.50	3.50	5.75
March	3.50	6.10	5.25	6.00	5.25	5.75	3.50	6.10
April	3.50	6.50	5.35	6.00	5.25	6.25	3.50	6.10
May	3.50	6.00	3.00	4.75	4.50	5.50	3.50	6.00
June	2.50	5.50	2.75	4.50	4.25	4.75	3.25	5.25
July	2.50	4.60	2.25	4.25	3.90	4.30	3.00	4.60
August	2.50	4.65	2.00	4.25	3.50	4.25	3.00	4.60
September	2.00	4.25	2.00	3.90	3.40	4.00	2.50	4.00
October	2.50	4.25	1.50	4.00	3.50	4.00	2.00	4.00
November	2.25	4.35	1.25	3.75	3.50	4.00	2.00	4.25
December	2.25	5.00	1.25	3.75	3.65	4.25	2.25	4.35
1901.								
January	2.75	4.75	2.75	4.25	3.75	4.50	3.00	4.90
February	2.75	4.75	3.25	4.25	4.00	4.50	3.00	4.75
March	2.75	5.00	3.25	4.50	4.00	5.10	3.00	4.85
April	3.00	5.15	3.75	4.50	4.25	5.10	3.00	5.00
May	2.75	5.00	3.50	5.00	4.00	4.75	2.50	4.40
June	2.75	4.65	3.00	4.10	3.25	4.60	2.25	4.25
July	2.65	4.35	3.00	3.75	3.00	3.75	2.25	4.05
August	2.65	4.05	2.25	3.50	3.00	3.75	2.00	3.60
September	2.75	4.00	2.25	3.40	3.00	3.65	2.00	3.60
October	2.75	4.40	2.10	3.25	3.10	3.50	2.25	4.25
November	2.50	4.30	2.10	4.50	3.15	3.75	2.25	3.75
December	2.50	4.50	2.30	4.50	3.25	4.00	2.50	4.50
1902.								
January	2.00	4.75	3.00	4.25	4.25	5.00	4.00	5.15
February	2.00	5.50	3.50	5.50	4.75	5.60	4.20	5.85
March	3.00	5.75	4.25	5.50	5.50	5.75	4.40	5.90
April	2.50	6.50	3.75	5.50	5.50	6.25	4.75	6.25
May	2.25	6.50	4.35	5.75	6.00	6.35	5.40	6.00
June	1.50	6.25	3.50	4.60	3.70	5.60	4.50	6.00
July	1.75	5.00	3.10	4.00	4.00	4.60	3.80	4.50
August	1.50	4.25	2.25	3.75	3.85	4.35	....	....
September	1.50	4.50	2.25	3.40	3.65	4.00	2.00	3.40
October	1.50	4.25	2.65	3.40	3.90	4.00	3.00	4.10
November	1.50	4.25	2.50	3.35	3.75	4.00	3.40	4.25
December	1.25	4.75	2.75	4.00	3.80	4.50	3.50	4.75

Wool product of the United States for 1902, by States.

[Estimates of Mr. S. N. D. North.]

States and Territories.	Number of sheep Apr. 1, 1902.	Average weight of fleece, 1902.	Per cent of shrinkage, 1902.	Wool, washed and unwashed.	Wool, scoured.
		Pounds.		*Pounds.*	*Pounds.*
Maine	239,972	6	40	1,439,832	863,899
New Hampshire	63,000	6.50	55	409,500	184,275
Vermont	160,000	6.75	56	1,080,000	475,200
Massachusetts	33,000	6	48	198,000	102,960
Rhode Island	6,500	5.50	42	35,750	20,735
Connecticut	34,000	5.50	41	187,000	110,330
New York	950,000	6	50	5,700,000	2,850,000
New Jersey	32,000	5	47	160,000	84,800
Pennsylvania	960,000	6	52	5,760,000	2,764,800
Delaware	6,500	6	50	39,000	19,500
Maryland	112,000	5	47	560,000	296,800
Virginia	380,000	4.50	39	1,710,000	1,043,100
North Carolina	205,000	4.25	42	871,250	505,325
South Carolina	50,000	4.25	42	212,500	123,250
Georgia	250,000	4	40	1,000,000	600,000
Florida	100,000	4	42	400,000	232,000
Alabama	225,000	4	40	900,000	540,000
Mississippi	230,000	4.50	42	1,035,000	600,300
Louisiana	155,000	4	45	620,000	341,000
Texas	1,440,000	6.50	68	9,360,000	2,995,200
Arkansas	160,000	4.50	42	720,000	417,600
Tennessee	300,000	4.25	40	1,275,000	765,000
West Virginia	544,400	5.50	47	2,994,200	1,568,926
Kentucky	700,000	5	40	3,500,000	2,100,000
Ohio	2,550,000	5.50	52	14,025,000	6,732,000
Michigan	1,600,000	6.50	52	10,400,000	4,992,000
Indiana	960,000	6.50	50	6,240,000	3,120,000
Illinois	625,000	7	52	4,375,000	2,100,000
Wisconsin	945,000	6.50	50	6,147,500	3,073,750
Minnesota	350,000	7	53	2,450,000	1,151,500
Iowa	640,000	6.50	50	4,160,000	2,080,000
Missouri	595,000	6.50	50	3,867,500	1,938,750
Kansas	160,000	8	65	1,280,000	448,000
Nebraska	330,000	8	63	2,640,000	976,800
South Dakota	507,000	6.50	58	3,295,500	1,911,100
North Dakota	450,000	6.50	60	2,925,000	1,170,000
Montana	5,081,000	7	63	35,567,000	13,159,790
Wyoming	4,614,750	7.50	65	34,610,000	12,113,500
Colorado	1,400,000	6.50	68	9,100,000	2,912,000
New Mexico	3,360,000	4.25	52	14,280,000	6,854,400
Arizona	669,000	7.50	67	5,017,500	1,655,775
Utah	2,600,000	6.50	65	16,900,000	5,915,000
Nevada	568,000	7.25	70	4,118,000	1,235,400
Idaho	2,500,000	7.25	66	18,125,000	6,162,500
Washington	560,000	8.50	74	4,760,000	1,217,600
Oregon	2,000,000	8.50	70	17,000,000	5,100,000
California	1,725,000	7.25	68	12,506,000	4,001,920
Oklahoma and Indian Territory	60,000	6.50	63	390,000	144,300
United States	42,184,122	6.50	60	274,346,032	109,771,085
Pulled wool			33	42,000,000	28,140,000
Total product, 1902				316,346,032	137,911,085

Importation of Mexican animals into the United States, fiscal year 1902.

Port of entry.	Cattle.	Sheep.	Lambs.	Asses.	Horses.	Mules.	Goats.	Hogs.
Eagle Pass, Tex	292				5	10	1,736	
El Paso, Tex	43,021				3	26		
Nogales, Ariz	20,550			9			114	64
San Diego, Cal	1,350	2,703	1,073	6			240	
Total	65,213	2,703	1,073	15	8	36	2,090	64

Range of prices of wool in Boston, monthly, 1898–1902.[a]

[Cents per pound.]

Date.	Ohio fine, unwashed.		Indiana quarter-blood, unwashed.		Ohio XX, washed.		Ohio, No. 1, washed.		Ohio Delaine, washed.		Michigan X, washed.	
	Low.	High.	Low.	High.	Low.	High.	Low.	High.	Low.	High.	Low.	High.
1898.												
January	20	21	22	24	30	30	30	31	30	32	24	25
February	20	21	22	23	30	30	30	31	31	31	24	24
March	19	20	22	23	29	30	30	30	30	31	23	24
April	19	19	21	22	29	29	29	30	30	30	22½	23
May	19	19	21	22	28	29	29	29	29	30	22½	23
June	19	20	22	23	28	29	29	29	29	29	22	22½
July	19	19	22	23	28	29	29	29	29	29	22½	22½
August	19	20	23	23	29	29	29	30	29	30	22	22½
September	19	19	22½	23	28½	29	29	30	29	30	22	22½
October	19	19	20	22	28	28½	29	29	29	29	22	22
November	19	19	20	21	28	28	29	29	29	29	22	22
December	18	19	20	21	27	28	29	30	28	29	21	22
1899.												
January	18	19	20	21	27	27	29	29	28	29	21	21
February	18	18½	21	21	26½	27	29	29	28	28½	21	21
March	16	17	20	21	25½	26	28½	29	27	28	20	21
April	17	18	21	22	26	26½	29	29	28	28	21	21
May	18	19	22	23	27	27½	29	29	28	29	21	22
June	19	19	22	23	27½	28	29	30	29	31	22	23
July	20	23	23	23	29	32	31	33	32	34	23	25
August	21	23	22	23	31	32	33	34	34	35	24	25
September	22	24	23	24	32	32	34	34	35	35	25	25
October	24	24	24	24	32	33	35	35½	35	36	25	25½
November	24	25	25	26	33	37	35½	37	36	40	26	30
December	25	26	27	28	37	38	37	39	40	40	29	30
1900.												
January	25	26	28	29	37	38	38	39	38	40	29	29
February	25	25	28	29	37	37	38	38	38	38	28	29
March	22	23	27	28	34	36	35	37	35	37½	24	27
April	21	22	26	27	32	34	35	35	35	35	24	24
May	20	21	25	26	31	32	34	35	33	35	24	24
June	19	20	25	25	29	31	32	33	32	33	23	24
July	19	19	24	25	29	29	31	32	31	32	23	23
August	19	19	23	24	28	29	30	31	29	31	22	23
September	18	19	23	24	27½	28	30	30	29	29	22	22
October	18	19	23	24	27	27½	28	29	27½	28	21½	22
November	18	19	23	24	27	28	28	29	28	30	22	23
December	18	18	23	24	28	28	28	28	29	29	22	22½
1901.												
January	17	18	23	23½	27	28	28	29	29	30	22	22
February	16½	17	23	24	27	27	27½	28	28	30	21	22
March	16½	18	22½	23	26	27	26	27	29	30	21	21
April	17	18	22	22½	26½	26½	26	27	28	30	21	21
May	17	17	20	21	26	26	25	26	28	30	20	20
June	17½	18	19½	20	26	26½	25	26	28	29	20	20½
July	18	18	20	20	26½	27	26	26	28	30	21	21½
August	18	18½	20	20	27	27	26½	26½	28	30	20½	21
September	18½	18½	20½	20½	26	27	26	26½	28	28½	21	21
October	18½	18½	20	20	26	26	25	26	28	28	20	21
November	19	19	20	21½	26	27	26	26½	27½	29	21	21
December	19	19½	21½	22	26½	27	26	27	28	29	21	21
1902.												
January	19½	20	22	22	27	27	27	27	28	29	21	21
February	20	20	22	22	27	27	27	27	28	29	21	21
March	19½	19½	21½	22	27	27	26½	27	28	29	21	21
April	19½	19½	21½	21½	27	27	26½	26½	28	28½	20½	21½
May	19	19½	20½	20½	27	27	26	26	28	28½	21	22
June	19	20	20½	21	27	27½	26	26	28	29	22	22
July	20	20	21	22	27	28	26	27	28	31	22	22
August	20	21	22	23	28	28	28	29	30	33	22	23
September	21½	21½	22	23	29	29	29	30	31½	32	23	23
October	21½	21½	23	23	30	30	30	30	31½	32	23	24
November	21½	22	23	23	29	31	30	31	21½	33	24	25
December	23	23	24	24	32	32	31	31	33	35	26	27

[a] Furnished by Commercial Bulletin, Boston.

Range of prices of wool in Boston, monthly, 1898–1902—Continued.

[Cents per pound.]

Date.	Fine selected Territory, staple scoured.		Fine medium Territory, clothing scoured.		Texas, 12 months, scoured.		Fine free fall, Texas or California scoured.		Pulled, A super, scoured.		Pulled, B super, scoured.	
	Low.	High.	Low.	High.	Low.	High.	Low.	High.	Low.	High.	Low.	High.
1898.												
January	55	57	49	52	52	53	43	45	45	48	41	43
February	54	56	48	50	50	53	42	45	45	47	40	42
March	50	54	45	48	48	50	39	42	45	47	40	41
April	49	50	44	45	46	48	38	39	45	46	38	40
May	47	50	43	45	47	49	38	39	45	47	38	40
June	47	49	43	45	47	48	38	38	43	45	36	38
July	47	49	45	45	48	48	38	39	45	46	38	40
August	47½	49	45	46	48	48	38	39	45	46	38	40
September	47	49	45	46	47	48	38	39	45	46	38	40
October	47	48	44	45	46	47	38	39	45	46	36	38
November	47	48	43	44	44	46	35	38	42	45	34	36
December	46	47	42	43	42	44	35	36	40	42	32	34
1899.												
January	45	46	40	42	42	44	32	33	40	41	32	33
February	44	45	40	40	42	43	32	33	40	42	32	34
March	42	45	38	40	40	42	30	32	40	40	30	31
April	45	45	40	40	41	42	32	33	40	42	31	34
May	45	47	40	42	43	46	33	37	41	44	33	37
June	48	52	43	47	47	50	38	41	42	45	34	37
July	53	58	48	51	51	55	42	45	44	47	36	38
August	55	58	50	52	53	55	43	45	45	47	36	38
September	56	63	51	55	54	56	44	46	46	48	37	40
October	62	63	54	55	56	58	44	46	47	48	40	42
November	63	72	56	62	59	63	46	52	48	52	43	50
December	72	75	60	62	63	65	50	52	53	57	50	52
1900.												
January	73	74	60	62	63	65	52	55	55	57	48	50
February	68	70	58	60	60	62	50	52	55	56	48	49
March	65	67	55	57	58	60	47	50	50	54	46	48
April	63	65	53	55	57	58	47	48	50	52	40	45
May	60	62	51	53	56	57	46	48	47	50	40	42
June	55	60	50	51	53	55	42	46	47	50	40	42
July	53	55	46	50	52	53	41	42	46	47	39	40
August	52	53	46	48	52	52	40	42	45	46	37	40
September	50	52	45	47	50	52	38	40	45	45	36	38
October	50	50	45	45	50	50	38	40	42	45	36	38
November	50	52	45	47	50	50	38	40	43	46	37	40
December	49	50	45	46	48	50	40	40	45	46	37	39
1901.												
January	50	50	39	43	48	48	38	40	42	45	37	38
February	48	50	38	39	47	50	37	40	40	45	35	35
March	43	45	35	38	43	45	36	38	38	42	34	35
April	45	47	38	40	43	47	36	37	38	40	33	34
May	45	47	40	40	45	47	36	37	35	38	31	32
June	45	47	40	42	45	47	36	37	35	39	30	30
July	46	48	42	43	47	50	36	40	37	40	31	33
August	47	50	43	44	48	50	40	40	38	40	33	33
September	49	50	44	44	50	50	40	40	38	40	33	33
October	49	50	42	44	50	50	40	40	38	40	32	32
November	49	50	43	44	48	50	40	42	38	40	32	33
December	49	50	43	44	48	50	40	42	38	40	34	34
1902.												
January	49	55	44	47	48	50	40	42	38	42	34	36
February	54	55	46	47	48	55	40	45	38	42	36	36
March	50	55	45	46	52	55	40	45	38	42	35	36
April	50	52	44	44	52	53	40	42	38	42	33	33
May	50	52	42	45	48	52	38	40	38	41	33	34
June	48	52	42	44	50	55	38	40	38	42	34	35
July	50	55	45	47	52	57	38	40	38	45	36	38
August	55	57	47	49	55	57	40	40	42	45	39	39
September	55	57	49	49	55	57	40	40	40	45	37	38
October	55	57	49	49	55	57	40	45	40	45	37	37
November	55	58	49	50	55	60	44	48	40	44	37	39
December	58	59	50	50	57	60	46	48	44	46	40	40

Wholesale prices of wool per pound in leading cities of the United States, 1898–1902.

Date.	Boston.		New York.		Philadelphia.		St. Louis.	
	XX Ohio, washed.		XX Ohio.		XX Ohio, washed.		Best tub-washed.	
	Low.	High.	Low.	High.	Low.	High.	Low.	High.
1898.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	30	30	30	31	29	30	30	30
February	30	30	30	31	30	31	29	30
March	29	30	30	31	29½	30½	28	29
April	29	29	30	31	28	30	27½	28
May	28	29	29	30	28	29	27	28
June	28	29	29	30	28	29	28	28
July	28	29	29	30	28	29	27½	28
August	29	29	29	30	28½	29½	27½	28
September	28½	29	29	30	29	30	27	27
October	28	28½	29	30	29	30	26	26½
November	28	28	28	29	28	29	25½	26
December	27	28	28	29	28	29	26	26
1899.								
January	27	27	28	29	27	28	26	26
February	26½	27	28	29	26½	27	26	26
March	25½	26	28	29	26½	27	25½	26
April	26	26½	28	29	26	27	26	26
May	27	27½	28	29	25½	26½	26	26½
June	27½	28	28	29	27	28	27	27
July	29	32	28	29	28½	30	26	26½
August	31	32	30	32	29	31	26½	27
September	32	32	30	32	31	32	26½	27½
October	32	33	30	33	32½	33½	28	28½
November	33	37	32	36	33	34	29	32
December	37	38	36	39	35	36	34	35
1900.								
January	37	38	36	39	36	37	29	35
February	37	37	36	39	36	37	35	36
March	34	36	36	39	36	37	33	35
April	32	34	36	37	34	35	33	34
May	31	32	34	37	33	34	33	34
June	29	31	34	36	30	32	28	32½
July	29	29	28	36	29	32	28	29
August	28	29	28	30	29	30	29	29
September	27½	28	28	30	28	30	29	29
October	27	27½	28	30	28	29	29	29
November	27	28	28	30	27	28	29	29½
December	28	28	28	30	27	28	29	29½
1901.								
January	27	28	26½	27	27	28	28	29½
February	27	27	26	26½	27	28	27	28
March	26	27	25½	26	26	27	27	27½
April	26½	26½	25½	26	25	27	27	27
May	26	26	25½	25½	25	27	25	27
June	26	26½	25½	25½	25	27	24	25
July	26½	27	25½	25½	25	26	....	....
August	27	27	25½	25½	26	27	24	24
September	26	27	25½	25½	26	27	24	25
October	26	26	25½	25½	26	27	24	24
November	26	27	25½	25½	26	27	24	25
December	26½	27	25½	25½	26	27	24	24½
1902.								
January	27	27	26	27	26	27	24	24½
February	27	27	26	27	26	27	24½	24½
March	27	27	26	27½	26	27	24	24
April	27	27	26½	27½	26	27	24	24
May	27	27	26½	27½	26	27	24	25
June	27	27½	26½	27½	26	27	24	25
July	27	28	26½	27½	26½	27½	24	25½
August	28	28	26½	27½	27½	28	25½	26½
September	29	29	26½	27½	27	29	26	26½
October	30	30	....	....	27	29	26	27
November	29	31	28	29	29	30	27½	28½
December	32	32	30	32	31	32	28	29

HOGS.

Numbers and values of hogs, 1880 to 1903, with exports.

Year.	On farms, January 1.			Exports for year ended June 30.		
	Number.	Value.	Average farm value.	Number.	Value.	Average price.
1880	34,034,100	$145,781,515	$4.28	83,434	$421,089	$5.05
1881	36,247,603	170,535,435	4.70	77,456	572,138	7.39
1882	44,122,200	263,543,195	5.97	36,368	509,651	14.01
1883	43,270,086	291,951,221	6.75	16,129	272,516	16.90
1884	44,200,893	246,301,139	5.57	46,382	627,480	13.53
1885	45,142,657	226,401,683	5.02	55,025	579,183	10.53
1886	46,092,043	196,569,894	4.26	74,187	674,297	9.09
1887	44,612,836	200,043,291	4.48	75,383	564,753	7.49
1888	44,346,525	220,811,082	4.98	23,755	193,017	8.13
1889	50,301,592	291,307,193	5.79	45,128	356,764	7.91
1890	51,602,780	243,418,336	4.72	91,148	909,042	9.97
1891	50,625,106	210,193,923	4.15	95,654	1,146,630	11.99
1892	52,398,019	241,031,415	4.60	31,963	364,081	11.39
1893	46,094,807	295,426,492	6.41	27,375	397,162	14.51
1894	45,206,498	270,384,626	5.98	1,553	14,753	9.50
1895	44,165,716	219,501,267	4.97	7,130	72,424	10.16
1896	42,842,759	186,529,745	4.35	21,049	227,297	10.80
1897	40,600,276	166,272,770	4.10	28,751	295,998	10.30
1898	39,759,993	174,351,409	4.39	14,411	110,487	7.67
1899	38,651,631	170,109,743	4.40	33,031	227,241	6.88
1900	....	....	....	51,180	394,813	7.71
1901	56,982,142	353,012,143	6.20	22,318	238,465	10.68
1902	48,698,890	342,120,780	7.03	8,368	88,330	10.56
1903	46,922,624	364,973,688	7.78	....	....	....

Number, average price, and total value of hogs in the United States on January 1, 1903.

States and Territories.	Swine.			States and Territories.	Swine.		
	Number.	Average price per head.	Value.		Number.	Average price per head.	Value.
		Dollars.	*Dollars.*			*Dollars.*	*Dollars.*
Maine	66,015	11.00	726,165	Indiana	2,712,297	8.24	22,349,327
New Hampshire	50,225	11.42	573,570	Illinois	3,747,495	9.43	35,338,878
Vermont	88,624	10.11	895,989	Wisconsin	1,686,885	8.98	15,148,227
Massachusetts	69,127	13.68	945,657	Minnesota	1,244,663	9.35	11,637,599
Rhode Island	12,452	11.85	147,556	Iowa	7,438,655	8.97	66,724,735
Connecticut	46,041	14.64	674,040	Missouri	3,050,487	7.33	22,360,070
New York	631,886	10.87	6,868,601	Kansas	1,875,692	8.52	15,980,896
New Jersey	157,213	11.77	1,850,397	Nebraska	2,889,133	8.73	25,222,131
Pennsylvania	970,953	10.13	9,835,754	South Dakota	804,329	9.62	7,737,645
Delaware	46,543	10.99	511,508	North Dakota	175,403	10.17	1,783,849
Maryland	290,353	8.63	2,505,746	Montana	51,745	10.84	560,916
Virginia	752,047	5.69	4,279,147	Wyoming	15,983	10.56	168,780
North Carolina	1,017,154	5.39	5,482,460	Colorado	75,133	8.49	637,879
South Carolina	614,972	5.88	3,616,035	New Mexico	21,383	6.93	148,184
Georgia	1,425,285	5.23	7,454,241	Arizona	16,112	7.53	121,323
Florida	395,528	3.00	1,186,584	Utah	58,575	9.15	535,961
Alabama	1,114,083	4.58	5,102,500	Nevada	14,158	7.00	99,106
Mississippi	1,078,291	5.12	5,520,850	Idaho	119,611	7.54	901,867
Louisiana	676,429	4.93	3,334,795	Washington	181,326	8.30	1,505,006
Texas	2,312,315	4.40	10,174,186	Oregon	271,704	6.79	1,844,870
Arkansas	1,013,409	4.52	4,580,609	California	511,311	7.63	3,901,303
Tennessee	1,043,231	5.66	5,904,687	Oklahoma	472,528	7.50	3,543,960
West Virginia	300,686	7.42	2,231,090	Indian Territory	561,444	6.18	3,469,724
Kentucky	998,431	5.99	5,980,602				
Ohio	2,756,096	8.75	24,115,840	United States	46,922,624	7.78	364,973,688
Michigan	999,183	8.76	8,752,843				

Wholesale prices of live hogs per 100 pounds in leading cities of the United States, 1898–1902.

Date.	Cincinnati. Packing, fair to good.		St. Louis. Mixed packers.		Chicago.		Omaha.	
	Low.	High.	Low.	High.	Low.	High.	Low.	High.
1898.								
January	$3.40	$3.90	$3.25	$3.90	$3.35	$4.00	$3.35	$3.80
February	3.65	4.20	3.60	4.10	3.60	4.27½	3.52½	4.00
March	3.75	4.00	3.70	4.10	3.65	4.17½	3.50	3.95
April	3.65	3.95	3.60	4.10	3.60	4.15	3.50	3.90
May	3.90	4.45	3.70	4.55	3.70	4.80	3.75	4.00
June	3.75	4.05	3.35	4.15	3.55	4.50	3.40	4.30
July	3.70	4.00	3.30	4.05	3.60	4.17½	3.40	3.95
August	3.85	4.00	3.50	4.05	3.45	4.20	3.50	3.92½
September	3.80	4.00	3.50	4.05	3.40	4.15	3.40	3.90
October	3.50	3.85	3.40	3.92½	3.25	4.00	3.35	3.80
November	3.35	3.70	3.20	3.80	3.10	3.85	3.10	3.65
December	3.15	3.50	3.10	3.65	3.15	3.75	3.10	4.55
1899.								
January	3.45	3.95	3.40	3.90	3.30	4.05	3.30	3.75
February	3.55	4.05	3.55	4.00	3.45	4.05	3.30	3.77
March	3.60	3.95	3.55	3.97½	3.50	4.00	3.40	3.75½
April	3.70	4.00	3.65	4.12½	3.50	4.15	3.50	3.85
May	3.65	3.92	3.60	3.95	3.45	4.05	3.45	3.80
June	3.65	4.00	3.60	3.90	3.45	4.00	3.25	3.75
July	3.80	4.65	3.75	4.60	3.55	4.70	3.67½	4.42
August	4.35	4.85	4.55	4.85	3.85	5.00	4.10	4.70½
September	4.25	4.80	4.45	4.75	3.90	4.90	4.10	4.52
October	4.15	4.75	4.10	4.65	3.80	4.90	3.95	4.57½
November	3.75	4.20	3.75	4.20	3.55	4.35	3.60	4.12½
December	3.75	4.40	3.80	4.47½	3.50	4.45	3.70	4.20½
1900.								
January	4.45	4.80	4.40	4.75	3.70	4.92½	4.15	4.72½
February	4.85	5.05	4.75	5.05	3.70	5.10	4.40	4.90
March	4.95	5.25	4.85	5.45	4.00	5.52½	4.50	5.17½
April	5.25	5.85	5.45	5.75	4.25	5.85	5.00	5.62½
May	5.15	5.45	5.20	5.50	4.00	5.57½	4.50	5.40
June	5.00	5.30	5.00	5.35	4.10	5.42½	4.57½	5.25
July	5.25	5.55	5.30	5.50	4.25	5.55	4.75	5.25
August	5.25	5.40	5.25	5.50	3.60	5.57½	4.75	5.25
September	5.40	5.60	5.35	5.60	3.50	5.70	4.90	5.35
October	4.45	5.30	4.75	5.40	3.35	5.55	4.25	5.25
November	4.65	5.00	4.70	5.00	3.40	5.10	4.30	4.97½
December	4.60	5.15	4.75	4.95	4.00	5.45	4.55	5.00
1901.								
January	5.15	5.35	4.90	5.30	4.25	5.47½	4.90	5.35
February	5.30	5.75	5.05	5.45	5.10	5.65	5.10	5.42½
March	5.60	6.05	5.25	6.10	4.90	6.20	5.17½	6.00
April	5.65	6.20	5.60	6.15	4.40	6.25	5.50	6.10
May	5.60	5.95	5.50	5.90	4.15	5.97½	5.00	5.82½
June	5.75	6.20	5.70	6.25	4.25	6.30	5.50	6.07½
July	5.70	6.20	5.80	6.20	3.00	6.35	5.25	6.02½
August	5.85	6.80	5.75	6.60	3.00	6.60	5.05	6.45
September	6.75	7.20	6.60	7.10	3.00	7.40	5.85	6.90
October	5.70	6.95	5.90	7.00	4.25	7.10	5.60	6.85
November	5.55	5.70	5.45	6.10	3.75	6.30	4.45	6.15
December	5.80	6.40	6.00	6.50	4.00	6.70	5.40	6.80
1902.								
January	6.05	6.50	6.10	6.90	4.40	6.85	5.40	6.70
February	6.65	6.50	5.85	6.50	4.40	6.85	5.25	6.45
March	6.20	6.95	5.80	6.92½	4.75	7.00	5.50	6.75
April	6.75	7.30	6.80	7.50	5.40	7.50	6.20	7.30
May	6.65	7.25	6.70	7.50	5.40	7.50	6.50	7.35
June	6.70	7.70	6.95	7.95	5.65	7.95	6.70	7.75
July	7.25	8.00	7.50	8.15	5.70	8.75	6.85	8.05
August	6.40	7.70	6.70	8.12½	5.30	7.95	6.50	7.65
September	6.90	7.80	7.30	8.20	5.50	8.20	7.05	7.75
October	6.50	7.70	6.40	7.90	4.50	7.90	6.50	7.45
November	5.85	6.60	6.05	6.90	4.60	6.95	5.95	6.55
December	6.05	6.65	5.95	6.70	4.60	6.85	5.75	6.60

Monthly average prices of live hogs in Chicago.[a]

[In dollars per 100 pounds.]

Month.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.
January	3.52½	4.22½	7.45	5.27½	4.25	3.90	3.30	3.67½	3.67½	4.53¾	5.13¾	6.20
February	3.50	4.57⅛	7.97½	5.07½	4.12½	3.97½	3.42½	3.93¾	3.75	4.82½	5.37½	6.00
March	4.20	4.55	7.55	4.72½	4.57½	3.90	3.80	3.91¼	3.75	5.07½	5.70	[illegible]
April	4.80	4.50	7.02½	4.97½	4.91¼	3.60	3.87½	3.87½	3.82½	5.47½	5.90	6.92½
May	4.62½	4.55	7.40	4.87½	[illegible]	3.27½	3.65	4.25	3.75	[illegible]	5.75	6.95
June	4.47½	4.97½	6.62½	4.75	4.65	3.15	3.37½	4.02½	3.72½	5.13¾	5.92½	7.30
July	5.07½	5.65	5.60	5.30	5.10	3.10	3.52½	[illegible]	4.12½	5.20	[illegible]	7.02½
August	5.10	5.40	5.05	5.35	4.62½	3.10	4.00	3.82½	4.42½	5.16¼	6.05	7.02½
September	4.87½	5.15	6.00	5.82½	4.10	2.97½	4.12½	3.77½	4.40	5.27½	6.60	7.50
October	4.47½	5.36¼	6.37½	5.12½	3.85	3.10	3.80	3.62½	4.35	[illegible]	[illegible]	[illegible]
November	3.82½	5.48¾	5.70	4.32½	3.52½	3.30	3.47½	3.47½	3.95	4.73¾	5.65	6.35
December	3.65	6.12½	5.12½	4.32½	3.47½	3.25	3.35	3.42½	4.00	4.75	[illegible]	6.25
Yearly average	4.34⅝	5.04⅝	6.49	4.99⅜	4.31	3.38½	3.61⅛	3.80¾	3.97¾	5.02¾	5.85⅛	6.78 7/16

a This table exhibits average cash prices of live hogs for the past twelve years. The monthly prices are the means between the lowest and highest prices for each month, and the yearly prices are averages of the monthly averages.

EGGS.

Wholesale prices of eggs per dozen in leading cities of the United States, 1898–1902.

Date.	New York. Average best fresh.		Cincinnati.		Chicago. Fresh.		St. Louis. Average best fresh.	
	Low.	High.	Low.	High.	Low.	High.	Low.	High.
1898.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	18	24	15	17½	15	22	12½	19
February	14	19	12	14	12½	16	10¾	14
March	10½	15¾	8	10½	8¾	12¼	8	11½
April	10	11¾	8	9	8½	10½	8	9¼
May	10½	12	9	9	9	11	8¼	9¼
June	10½	12½	9	9	9¼	11½	8¾	9
July	13	14	9	9	9	11½	9	9
August	14½	15½	9	12	9	12½	9	13
September	15½	17½	12	13	12	14½	11½	13½
October	17½	20	13	14	13½	16½	12½	15
November	20	24	14	19	17½	22	15½	19
December	25	27	19	20	21	26	19	20
1899.								
January	17	29	14	22	15	27	13½	22
February	19	35	15	24	16	35	13½	22
March	12½	30	10½	18	11½	20	10	17
April	12½	14½	10½	11½	11	13	10	11½
May	13¼	16	11	12	10¾	13	10¼	11¼
June	14½	15½	10	11	11	13¼	10	11
July	15	16½	8½	9½	10	13	9	10
August	15	18	9	11½	10	12½	9	12
September	18	21	12½	15	11	16½	11	15½
October	20	22	15	16½	15	17	14	15½
November	21	24	17	17	17	18	16	17
December	21	24	17	17	17	20	17	17
1900.								
January	17	26	15	19	13¾	20	12½	17½
February	13½	19	12½	14	12	16	10½	14
March	12	17	9¼	14	10	16	8¾	15½
April	12	13½	9½	11	10½	11½	8¾	11½
May	12½	14½	10½	11	10½	11½	9½	10
June	13	15	10½	10½	10	11½	8	10
July	13	17	9	10	10½	11½	7½	9½
August	14	18	9	12	11½	13½	9½	11½
September	12½	14	11½	15	13	16	16	19½
October	19	21	14	15	15½	17½	14	16½
November	20	27	18	20	18	23	16	18½
December	23	29	18	22	20	26	18	23

Wholesale prices of eggs per dozen in leading cities of the United States, 1898–1902—Continued.

Date.	New York. Average best fresh.		Cincinnati.		Chicago. Fresh.		St. Louis. Average best fresh.	
	Low.	High.	Low.	High.	Low.	High.	Low.	High.
1901.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	19½	27	16	20	17	23	15½	18½
February	17	21½	14	18	14	19½	14½	17½
March	13	17½	11	14	11½	17	10½	13
April	13½	14	11	12	12	12¾	10½	12
May	13½	14½	11	11	10½	12¼	10	10¾
June	13	14½	10	11	10	12	8½	10
July	14	18	9	10	10½	13	6	9
August	16	20	9	13½	12½	14½	9	11½
September	18	22	13½	17	14	17	12	16½
October	20	23	17	18	16½	19	16	18
November	22	29	18½	23	19	24	18	22
December	23	31	23	27	23	28	22	25
1902.								
January	26	34	22	30	18	28	22	26
February	27	37	21	32	23½	33½	21	32
March	15½	30	13	25	13¾	26½	13½	26½
April	15½	18	14	15	14	16	13½	15½
May	16	17½	14	15	14½	15½	13½	15
June	17	20	14	14½	15	17	13	15½
July	18	20½	14	14½	17	18	11¼	14½
August	18	21	14	16	16	18	13	16
September	20	24	16½	18½	17½	20½	15	20
October	21	25	18	21	20	22	17	18½
November	22	26	19	23	21½	24	19½	22½
December	24	29	21	24	20	25	20½	22½

Keeping Eggs for Market.

Fresh eggs may be kept in a fairly good condition for food in several ways. The more important of these are cold storage and the use of a coating of water glass. Eggs kept steadily in a temperature of 34° Fahrenheit will be good after many months.

The difficulty of maintaining so low a temperature outside of a large warehouse makes it impracticable to keep a few dozens in this way.

For the farmer and the small dealer the use of water glass is to be recommended. It is commonly sold in two forms; a sirup-thick liquid, of about the consistency of molasses, and a powder. The thick sirup, the form perhaps most usually seen, is sometimes sold wholesale as low as 1¾ cents per pound in carboy lots. The retail price varies, though 10 cents per pound seems to be the price commonly asked. A solution of the desired strength for preserving eggs may be made by dissolving 1 part of the sirup-thick water glass in 10 parts, by measure, of water. If the water glass powder is used less is required for a given quantity of water. Much of the water glass offered for sale is very alkaline. Such material should not be used, as the eggs preserved in it will not keep well. Only pure water should be used in making the solution, and it is best to boil it and cool it before mixing with the water glass. The solution should be carefully poured over the eggs packed in a suitable vessel, which must be clean and sweet. If wooden kegs or barrels are used they should be thoroughly scalded before packing the eggs in them. The packed eggs should be stored in a cool place. If they are placed where it is too warm, silicate deposits on the shell and the eggs do not keep well. It is best not to wash the eggs before packing, as this removes the natural mucilaginous coating on the outside of the shell. One gallon of the solution is sufficient for 50 dozen eggs if they are properly packed.

TRANSPORTATION RATES.

Grain; average rates, in cents per bushel, from St. Louis to New Orleans by river. [a]

Year.	Grain in sacks, per 100 pounds.	Per bushel.		
		Wheat in bulk.	Corn and rye.	
			High water.	Low water.
1866			9.05	10.93
1867			11.09	14.83
1868			6.23	9.84
1869			6.32	8.42
1870			9.23	13.65
1871			6.71	16.29
1872			9.79	19.04
1873			6.15	9.67
1874			4.95	8.09
1875			4.87	10.01
1876			5.02	11.30
1877	20.04	8.11	7.63	8.59
1878	17.36	7.19	4.96	8.93
1879	18	7.75	5	11
1880	19	8.25	7	9.50
1881	20	6	4	8
1882	20	6.42	5.50	7
1883	17.75	5.50	5	7
1884	14	6.63	5	7
1885	15	6.40	5	7
1886	16	6.50	5	7
1887	18.25	6	5	7
1888	15	6.50	5	7.50
1889	17.93	5.95	5	7
1890	15.66	6.58	5	7
1891	16.28	6.85	5	7.50
1892	16.87	6.50	5	7
1893	17.54	6.55		
1894	17.14	5.80		
1895	12.50	5.95		
1896	14.55	5		
1897	15	4.98		
1898	10	4.50		
1899	10	4.50		
1900	10	a4.25		
1901	10	a4.25		
1902	10	a4.20		

a F. o. b. New Orleans.

Live stock and dressed meats, Chicago to New York by rail, average rates in cents per 100 pounds.

Year.	Cattle.	Hogs.	Sheep.	Horses and mules.	Dressed beef.	Dressed hogs.	
						Refrigerator cars.	Common cars.
1880	55	43	65	60	88		
1881	35	31	61	60	56		
1882	36	29	53	60	57		
1883	40	32	50	60	64		
1884	31	28	44	60	51		
1885	31	26	43	60	54		
1886	33	30	42	60	61	53	48
1887	33	32	40	60	62	59	54
1888	22	26	31	60	46	46	44
1889	25	30	30	60	47	47	45
1890	23	28	30	60	39	39	39
1891	27	30	30	60	45	45	45
1892	28	28	30	60	45	45	45
1893	28	20	30	60	45	45	45
1894	28	30	30	60	45	45	45
1895	28	30	30	60	45	45	45
1896	28	30	30	60	45	45	45
1897	28	30	30	60	45	45	45
1898	28	30	30	60	45	45	45
1899	a25	25	25	60	40	40	40
1900	28	30	30	60	45	45	45
1901	28	30	30	60	42.9	42.9	42.9
1902	28	30	30	60	41.2	41.2	41.2

a Rates did not go into effect until February 1, 1899; until that time the 1898 rates governed.

Average rates, in cents per passenger per mile.

Year.	Fitchburg R. R.	Boston and Albany R. R.	New York Central and Hudson River R. R.	Erie R. R.	Lake Shore and Michigan Southern Rwy.	Pennsylvania R. R.	Pittsburg, Fort Wayne and Chicago Rwy.	Chesapeake and Ohio Rwy.	Illinois Central R. R.	Chicago, Rock Island and Pacific Rwy.	Chicago, Milwaukee and St. Paul Rwy.	Chicago and Alton Rwy.	Union Pacific Rwy.	Louisville and Nashville R. R.	All railways in the United States.
1875	1.910	2.180	1.885	1.955	2.088	2.259	2.407	3.231	2.882	2.687	2.690	2.755	2.878	3.219	2.378
1876	1.864	2.099	1.693	1.859	1.846	1.819	1.830	3.322	2.804	2.626	2.805	2.614	2.974	3.018	2.183
1877	1.947	2.174	1.953	1.772	2.182	2.185	2.192	3.786	2.942	2.772	2.994	2.798	3.140	3.167	2.458
1878	1.969	2.217	1.978	2.158	2.255	2.277	2.258	3.738	3.122	2.933	3.029	2.795	3.226	3.345	2.573
1879	1.888	2.137	2.044	2.090	2.221	2.253	2.228	3.630	3.066	2.971	2.908	2.417	------	3.444	2.484
1880	1.885	2.096	1.999	2.041	2.135	2.222	2.156	2.959	2.514	2.806	2.868	2.076	------	3.476	2.442
1881	1.820	1.970	1.862	2.016	1.988	2.152	1.895	2.989	2.164	2.666	2.856	1.828	3.341	3.168	2.446
1882	1.715	1.993	1.808	1.948	2.156	2.249	2.024	2.605	2.388	2.505	2.579	1.951	3.300	2.706	2.391
1883	1.790	2.088	1.986	1.673	2.196	2.297	2.193	2.373	2.424	2.504	2.516	2.141	3.128	2.614	2.402
1884	1.651	1.908	1.942	2.189	2.170	2.258	2.222	2.379	2.225	2.572	2.553	1.900	2.952	2.342	3.323
1885	1.833	1.838	1.419	1.756	2.058	1.950	1.569	2.270	2.211	2.466	2.563	2.026	2.749	2.103	2.216
1886	1.756	1.853	1.845	1.890	2.098	2.114	2.130	2.131	2.208	2.420	2.415	2.023	2.135	2.436	2.142
1887	1.89	1.880	1.989	2.039	2.260	2.125	2.255	2.074	2.268	2.328	2.538	2.062	2.301	2.394	2.245
1888	1.978	1.976	1.957	1.851	2.280	2.111	2.10	2.025	2.197	2.312	2.445	2.123	2.248	2.429	2.319
1889	1.957	1.869	1.932	1.722	2.286	2.076	2.18	1.709	1.927	2.285	2.415	2.128	2.135	2.370	2.165
1890	1.915	1.858	1.910	1.584	2.254	2.094	2.25	2.056	2.022	2.149	2.359	2.004	2.045	2.403	2.167
1891	1.869	1.818	1.905	1.601	2.105	2.070	2.23	2.155	2.073	2.322	2.408	2.205	2.059	2.483	2.142
1892	1.916	1.828	1.887	1.589	2.183	2.028	2.00	2.181	2.101	2.308	2.464	2.043	2.104	2.448	2.123
1893	1.869	1.835	1.832	1.551	2.195	1.968	1.98	1.989	1.999	2.095	2.414	1.981	1.987	2.432	2.103
1894	1.851	1.794	1.857	1.509	2.069	1.993	2.00	1.905	1.925	1.891	2.191	1.778	1.758	2.365	1.985
1895	1.819	1.770	1.837	1.560	2.215	1.971	2.06	1.980	1.995	2.146	2.411	2.119	1.962	2.318	2.040
1896	1.769	1.752	1.838	1.641	2.148	1.950	1.88	1.952	1.979	2.108	2.375	2.117	2.075	2.187	2.019
1897	1.811	1.754	1.842	1.543	2.108	1.958	2.02	1.980	1.979	2.153	2.189	2.116	2.101	2.254	2.022
1898	1.826	1.750	1.806	1.548	2.032	a1.953	2.02	1.943	1.938	2.092	2.362	2.058	1.945	2.152	1.973
1899	1.800	1.744	1.766	1.536	2.074	a1.937	2.02	1.860	2.014	2.036	2.337	2.055	1.941	2.243	1.925
1900	1.805	1.754	1.793	1.540	2.223	1.952	2.05	1.973	2.021	2.044	2.346	1.908	1.868	2.318	2.003
1901	(b)	1.742	1.799	1.541	1.993	1.992	2.09	1.984	1.960	2.095	2.324	1.936	2.055	2.355	2.013

a Excludes ferry earnings at Jersey City, N. J. b Leased by the Boston and Maine Railroad.

Average rates on grain, flour, and provisions, in cents per 100 pounds, through from Chicago to European ports, by all rail to seaboard and thence by steamers, from 1893 to 1902.

Shipped to—	Articles.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.
Liverpool	Grain	34.1	32.5	32	33.5	33.6	34.35	29.72	29.48	21.47	20.85
Do	Sacked flour	35.13	33.16	34	34.3	36.81	37.66	30.12	27.9	23	23.5
Do	Provisions	45.47	44.06	41.81	44.91	44.4	47.15	40.5	48.84	36	36.25
Glasgow	Grain	35.85	34.63	34.19	34.22	35.23	36	32.35	30.98	24.1	21.75
Do	Sacked flour	36.25	35.03	36.25	36.5	39.06	39.06	31.25	31.56	24.38	22.75
Do	Provisions	48.28	46.59	49.69	49.97	52.5	52.5	44.69	55.31	45.16	41.88
London	Grain	37.6	32.88	33.29	33.48	34	35	30.6	31.1	23.23	21.75
Do	Sacked flour	37.94	34.93	35.13	35.28	36.12	37.25	33.5	35.01	25.5	24
Do	Provisions	48.28	45.75	46.03	47.15	48.14	49.69	44.14	55.87	44.75	39.06
Antwerp	do	48.28	46.88	48.28	49.69	51.09	52.5	47.5	51.69	43.25	41.5
Hamburg	do	52.5	50	50	51	51	52	46	50	44	39
Amsterdam	do	50	50	50	52	52	52.5	47	51	45	40
Rotterdam	do	50	50	48	52	52	52.5	47	51	45	40
Copenhagen	do	55.31	55.31	55.31	58.12	57.28	58.13	51.72	55.31	47.75	42
Stockholm	do	66.56	66.56	66.56	69.37	68.53	69.25	62.97	64.5	53.25	45
Stettin	do	55.31	55.31	55.31	58.12	57.28	58.13	51.72	55.31	47.75	42
Bordeaux	do	60	62.5	64.13	64.13	64.13	65.75	59.12	64.12	54.25	51.25

IMPORTS AND EXPORTS OF AGRICULTURAL PRODUCTS.

[From Division of Foreign Markets.]

Agricultural imports of the United States during the five years ended June 30, 1902.

Articles imported.	1898.		1899.		1900.		1901.		1902.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
ANIMAL MATTER.										
Animals, live:										
Cattle—										
For breeding purposes,[a] number	577	$76,631	624	$95,353	1,045	$202,615	1,249	$273,728	1,928	$375,096
Other .... number	291,012	2,836,592	199,128	2,225,009	179,961	2,055,079	144,773	1,657,705	94,099	1,233,626
Total cattle ...... do	291,589	2,913,223	199,752	2,320,362	181,006	2,257,694	146,022	1,931,433	96,027	1,608,722
Horses—										
For breeding purposes,[a] number	800	145,456	1,067	296,252	1,284	357,272	1,910	714,623	2,944	1,273,607
Other .... number	2,285	269,443	1,975	254,798	1,818	239,320	1,875	271,115	1,888	303,627
Total horses ...... do	3,085	414,899	3,042	551,050	3,102	596,592	3,785	985,738	4,832	1,577,234
Sheep—										
For breeding purposes .. do	3,047	42,805	2,396	46,132	2,427	48,324	2,032	48,989	2,059	46,063
Other .... do	389,267	1,063,517	343,515	1,153,949	379,365	1,316,702	329,456	1,187,288	264,894	910,647
Total sheep ...... do	392,314	1,106,322	345,911	1,200,081	381,792	1,365,026	331,488	1,236,277	266,953	956,710
All other, including fowls	....	239,681	....	265,032	....	311,638	....	325,507	....	481,865
Total live animals	....	4,674,125	....	4,336,525	....	4,530,950	....	4,478,955	....	4,624,561
Beeswax .... pounds	272,097	72,473	452,016	109,957	213,815	51,526	213,773	55,884	408,703	115,967
Bones, hoofs, and horns	....	492,544	....	701,959	....	830,063	....	674,308	....	692,634
Bristles:										
Crude, unsorted ...... pounds	1,203	416	21,421	12,399	27,140	22,330	51,539	22,310	40,557	28,446
Sorted, bunched, or prepared, pounds	1,533,887	1,248,703	1,835,156	1,445,853	2,503,018	2,130,537	1,633,036	1,707,887	1,972,572	2,018,885
Total .... pounds	1,535,090	1,249,119	1,856,577	1,458,252	2,530,158	2,152,867	1,684,575	1,730,197	2,013,129	2,047,331

[a] Including teams of immigrants.

Agricultural imports of the United States during the five years ended June 30, 1902—Continued.

Articles imported.	1898.		1899.		1900.		1901.		1902.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
ANIMAL MATTER—continued.										
Cochineal [a] .... pounds..	158,055	$45,762	97,563	$23,207	157,917	$31,211	114,414	$20,414	128,821	$24,865
Dairy products:										
Butter [b] .... do....	31,984	5,474	23,700	3,962	49,791	9,769	93,669	19,441	453,978	80,725
Cheese [b] .... do....	10,012,188	1,343,173	11,826,175	1,563,128	13,455,990	1,761,613	15,329,029	2,120,283	17,067,714	2,551,366
Milk	....	67,729	....	52,603	....	42,686	....	48,062	....	33,457
Total	....	1,416,376	....	1,619,693	....	1,814,068	....	2,187,796	....	2,665,548
Eggs .... dozens..	166,319	8,078	225,180	21,300	135,038	8,741	126,520	10,515	384,070	37,432
Egg yolks	....	(c)	....	11,322	....	19,594	....	246	....	6,869
Feathers and downs, crude	....	2,238,955	....	1,768,092	....	1,736,453	....	1,524,859	....	2,032,566
Fibers, animal:										
Silk—										
Cocoons .... pounds..	10,492	3,999	13,537	2,288	30,004	18,235	132	139	4,118	1,695
Raw, or as reeled from the cocoon, pounds	10,315,162	31,446,800	9,691,145	31,827,061	11,259,310	44,549,672	9,139,617	29,353,777	12,620,682	41,714,331
Waste .... pounds..	1,762,297	659,267	1,545,701	650,278	1,784,404	761,853	1,265,806	697,449	1,610,026	919,325
Total silk .... do....	12,087,951	32,110,066	11,250,383	32,479,627	13,073,718	45,329,760	10,405,555	30,051,365	14,234,826	42,635,351
Wool and hair of the camel, goat, alpaca, and like animals—										
Class 1, clothing .... pounds..	45,442,987	7,969,611	12,976,999	1,948,954	37,404,243	8,009,985	30,681,475	5,025,194	63,131,670	7,927,919
Class 2, combing .... do....	4,320,873	859,599	2,155,419	587,061	12,631,283	2,633,721	5,484,264	1,074,761	6,091,024	1,071,866
Class 3, carpet .... do....	83,031,342	7,954,482	61,603,791	5,786,882	105,892,929	9,617,230	67,417,766	6,429,986	94,354,272	8,712,003
Total wool .... do....	132,795,202	16,783,692	76,736,209	8,322,897	155,928,455	20,260,936	103,583,505	12,529,881	166,576,966	17,711,788
Total animal fibers, pounds	144,883,153	48,893,758	87,986,592	40,802,524	169,002,173	65,590,696	113,989,060	42,581,246	180,811,792	60,347,139
Gelatin manufactures	....	25,967	....	21,961	....	30,361	....	23,230	....	(d)
Glue .... pounds..	4,103,814	428,597	5,358,063	479,450	5,577,082	537,492	4,540,951	473,341	4,757,762	477,036
Grease. (*See* Meat and meat products.)										
Gut	....	42,879	....	15,965	....	12,138	....	1,826	....	15,826
Hair	....	1,839,668	....	1,814,964	....	2,415,984	....	1,611,424	....	1,980,319
Hide cuttings and other glue stock..	....	408,262	....	708,968	....	1,223,521	....	1,057,931	....	696,459

Hides and skins, [e] other than furs:										
Cattle hides [f] .... pounds..	126,243,595	13,624,989	130,396,020	13,621,943	163,865,165	19,408,217	129,174,624	14,647,413	148,627,907	17,474,039
Goatskins .... do....	64,923,487	15,776,601	69,728,945	18,488,325	81,998,818	21,987,674	73,745,596	20,577,033	88,038,516	25,478,179
Other .... do....	54,607,534	7,667,342	66,965,785	9,877,771	100,070,795	16,539,807	77,989,617	12,995,567	89,457,680	15,054,400
Total .... do....	245,774,616	37,068,932	267,690,750	41,988,043	345,934,778	57,935,698	280,909,837	48,220,013	326,124,103	58,006,618
Honey .... gallons..	96,604	38,158	126,217	51,599	146,860	70,857	182,196	83,599	167,301	56,383
Meat and meat products:										
Meat—										
Sausages, bologna		82,546		93,714		95,944		80,605		109,791
Other, including meat extracts		345,108		263,845		365,589		407,003		464,745
Total meat		427,654		357,559		461,533		487,608		574,536
Meat products—										
Grease [g]		593,239		696,674		779,666		756,453		981,494
Oils .... gallons..	14,163	5,715	9,056	1,569	18,050	3,255	59,131	12,858	161,306	29,060
Rennets		90,757		93,284		66,907		88,744		93,358
Sausage casings		537,871		622,949		646,889		642,212		754,588
Stearin .... pounds..	(c)	(c)	1,805,977	25,546	1,524,722	27,895	3,684,720	67,686	7,634,293	492,287
Other [h]		80,031		114,843		106,163		54,657		380,463
Total meat products		1,307,613		1,554,865		1,650,775		1,622,620		2,731,190
Total meat and meat products		1,735,267		1,912,424		2,002,308		2,110,228		3,305,726
Oils, animal. (*See* Meat and meat products.)										
Rennets. (*See* Meat and meat products.)										
Stearin. (*See* Meat and meat products.)										
Total animal matter		109,633,068		97,825,938		141,084,302		106,825,658		137,133,199

[a] Classed as agricultural for the first time in 1902. The statistics for earlier years are inserted merely for purposes of comparison, and are not included in the total agricultural imports for 1898–1901.

[b] Including substitutes for.

[c] Not stated.

[d] No longer classed as agricultural.

[e] Excluding sheepskins with the wool on, and since 1898 also bird skins and fishskins.

[f] Exclusive of cattle hides, free under reciprocity treaty with Hawaii.

[g] Including oils used for soap making, wire drawing, and leather manufacture, and prior to July 21, 1897, including tallow (free of duty).

[h] Exclusive of tallow (free of duty) prior to July 21, 1897; in 1899 and 1900 including tallow, free under reciprocity treaty with Hawaii, of which 142,050 pounds, valued at $5,196, were imported in 1899, and 10,690 pounds, valued at $437, in 1900.

Agricultural imports of the United States during the five years ended June 30, 1902—Continued.

Articles imported.	1898.		1899.		1900.		1901.		1902.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
VEGETABLE MATTER.										
Argols, or wine lees ....pounds..	19,202,629	$1,591,027	23,300,762	$1,914,450	27,339,489	$2,388,693	28,598,781	$2,476,482	29,276,148	$2,263,588
Breadstuffs. (*See* Grain and grain products.)										
Broom corn ....tons..	(a)	(a)	(a)	(a)	549	49,612	6	618	5	553
Cider ....gallons..	(a)	(a)	(a)	(a)	2,647	2,287	4,376	3,496	8,006	7,159
Cocoa and chocolate:										
Cocoa—										
Crude, and leaves and shells of..................pounds..	25,717,404	3,492,033	35,512,364	5,064,703	41,746,872	5,657,283	45,924,353	6,472,829	51,379,396	6,656,504
Prepared, or manufactured ....pounds..	815,824	290,844	926,219	295,413	1,012,368	313,561	977,003	288,840	973,970	295,921
Total cocoa ......do....	26,533,228	3,782,877	36,438,583	5,360,116	42,759,240	5,970,844	46,901,356	6,761,669	52,353,366	6,952,425
Chocolate ....do....	992,288	149,866	1,124,515	201,439	1,209,012	240,141	718,848	141,892	525,221	101,536
Total cocoa and chocolate.........pounds..	27,525,516	3,932,743	37,563,098	5,561,555	43,968,252	6,210,985	47,620,204	6,903,561	52,878,587	7,053,961
Coffee ....do....	870,514,455	65,067,631	831,827,063	55,275,470	787,991,911	52,467,943	854,871,310	62,861,339	1,091,004,252	70,982,155
Coffee substitutes:										
Chicory root—										
Raw, unground........do....	315,707	5,100	159,269	2,353	1,216,518	17,762	511,693	9,833	238,272	4,687
Roasted, ground, or otherwise prepared ....pounds..	(a)	(a)	335,347	11,061	384,957	12,941	348,597	11,098	298,671	10,451
Total chicory root, pounds..............	(a)	(a)	494,616	13,414	1,601,475	30,703	860,290	20,931	536,943	15,138
Other ....pounds..	857,810	29,562	992,395	36,370	1,262,659	49,029	875,420	38,354	400,527	20,499
Total coffee substitutes ....pounds..	(a)	(a)	1,487,011	49,784	2,864,134	79,732	1,735,710	59,285	937,470	35,637
Curry and curry powder	....	(a)	....	7,383	....	8,770	....	7,497	....	9,010

Fibers, vegetable:										
Cotton .... pounds..	52,660,363	5,019,563	50,158,158	5,013,146	67,398,521	7,960,945	46,631,283	6,787,828	96,715,680	11,712,170
Flax .... tons..	5,579	1,193,597	6,474	1,306,520	6,967	1,316,254	6,876	1,880,717	7,772	2,004,915
Hemp .... do....	4,017	560,334	3,941	477,108	3,409	450,269	4,057	622,814	6,654	1,013,911
Istle, or Tampico fiber .... do....	2,563	130,294	4,419	284,177	5,748	475,090	2,334	163,566	7,819	495,254
Jute and jute butts........ do....	112,303	2,543,498	83,161	2,296,189	192,693	3,956,413	103,140	4,412,482	128,963	4,447,987
Manila hemp........ do....	50,270	3,239,341	53,195	6,211,475	42,624	7,152,363	43,735	7,115,446	56,453	10,555,272
Sisal grass........ do....	69,222	5,165,900	71,898	9,211,377	76,921	11,782,263	70,075	7,972,564	89,583	11,951,213
Other........ do....	9,791	609,222	7,466	513,247	10,953	891,128	8,013	764,917	9,083	977,110
Total........	....	18,465,689	....	25,313,239	....	31,334,750	....	29,720,334	....	43,258,132
Flowers, natural[b]	....	11,914	....	19,392	....	30,621	....	21,268	....	30,382
Fruit juices, n. e. s.:										
Prune juice, or prune wine, gallons........	26,174	23,285	35,047	27,204	40,761	33,215	37,686	26,885	42,817	32,925
Other, including cherry juice, gallons........	52,968	25,879	44,841	23,173	48,727	30,087	42,152	20,989	29,108	15,114
Total .... gallons..	79,142	49,164	79,888	50,377	89,488	63,302	79,838	47,874	71,925	48,039
Fruits and nuts:										
Fruits—										
Fresh or dried—										
Bananas	....	4,236,418	....	5,665,588	....	5,877,835	....	6,550,186	....	7,307,437
Currants........ pounds..	25,186,210	827,987	30,849,253	798,357	36,251,779	916,908	16,049,198	916,994	36,238,976	1,238,756
Dates........ do....	13,551,424	371,992	12,940,305	324,087	19,962,512	410,319	18,431,917	372,400	29,013,681	344,833
Figs........ do....	9,628,426	509,092	7,281,058	356,762	8,512,467	513,895	9,933,871	452,515	11,087,131	487,733
Lemons .... do....	(a)	2,848,139	235,942,718	4,398,094	160,198,056	3,666,881	148,514,614	2,516,856	161,975,309	3,320,359
Oranges .... do....	(a)	883,722	83,497,569	1,337,556	68,618,938	1,057,641	50,332,914	718,457	52,742,476	784,640
Plums and prunes.. do....	306,992	39,696	690,349	63,574	443,457	47,760	715,971	62,889	522,478	44,077
Raisins .... do....	6,593,833	381,889	4,933,201	282,400	10,309,493	531,124	3,860,836	297,631	6,683,545	399,973
Other[c]	....	1,294,855	....	1,579,652	....	1,989,546	....	2,059,130	....	2,053,588
Total fresh or dried....	....	11,406,655	....	14,566,020	....	15,041,279	....	14,951,647	....	15,981,395
Prepared or preserved[d]	....	922,357	....	1,020,644	....	1,243,479	....	1,366,801	....	1,451,788
Total fruits........	....	12,329,012	....	15,586,664	....	16,284,758	....	16,317,848	....	17,433,184

[a] Not stated.
[b] Exclusive of natural flowers free of duty prior to July 24, 1897.
[c] Including orange and lemon peel, not preserved, candied, or dried, and prior to 1902 nuts free of duty, except cocoanuts.
[d] Including edible fruits, dried, not elsewhere specified.

Agricultural imports of the United States during the five years ended June 30, 1902—Continued.

Articles imported.	1898.		1899.		1900.		1901.		1902.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
VEGETABLE MATTER—continued.										
Fruits and nuts—Continued.										
Nuts—										
Almonds ....pounds..	5,746,362	$659,659	9,957,427	$1,222,587	6,317,633	$949,083	5,140,232	$946,138	9,868,982	$1,240,886
Cocoanuts	....	575,935	....	625,789	....	702,947	....	804,233	....	832,383
Other *a*	....	1,002,344	....	879,166	....	1,326,804	....	1,518,484	....	1,971,072
Total nuts	....	2,237,938	....	2,727,542	....	2,978,834	....	3,268,855	....	4,044,341
Total fruits and nuts...	....	14,566,950	....	18,314,206	....	19,263,592	....	19,586,703	....	21,480,525
Ginger, preserved or pickled, pounds	(*b*)	14,295	142,698	6,309	429,198	17,917	340,690	17,306	660,494	28,194
Grain and grain products:										
Grain—										
Barley ....bushels..	124,864	43,863	110,475	53,696	189,757	91,040	171,004	84,073	57,406	33,221
Corn (maize) ....do....	3,417	1,479	4,171	1,618	2,480	1,942	5,169	3,418	18,278	13,418
Oats ....do....	9,098	3,368	11,500	4,432	41,523	18,369	20,735	8,995	25,812	12,085
Rye ....do....	32,938	13,323	402	982	330	366	46	33	88	97
Wheat ....do....	2,046,590	1,948,289	1,871,101	1,407,625	316,968	240,496	600,212	418,327	118,612	78,640
Total grain ......do....	2,216,847	2,010,322	1,997,649	1,468,353	551,058	352,204	797,166	514,846	220,196	137,461
Grain products—										
Meal and flour—										
Oatmeal ....pounds..	287,910	15,697	298,764	17,740	234,959	13,499	204,694	11,667	236,981	13,628
Wheat flour ....barrels..	2,744	12,230	905	4,057	717	3,771	642	3,430	420	2,610
Total meal and flour...	....	27,927	....	21,797	....	17,270	....	15,097	....	16,238
Malt, barley ....bushels..	4,769	4,412	4,984	4,447	4,399	4,127	4,580	4,635	3,019	2,929
Other *c*	....	917,989	....	851,000	....	1,023,226	....	1,078,995	....	1,380,658
Total grain products...	....	950,328	....	877,244	....	1,044,623	....	1,098,727	....	1,399,825
Total grain and grain products	....	2,960,650	....	2,345,597	....	1,396,827	....	1,613,573	....	1,537,286
Hay ....tons..	3,887	34,659	19,872	115,409	143,890	1,019,743	142,620	1,128,610	48,415	381,417
Hops ....pounds..	2,375,922	648,155	1,319,319	591,755	2,589,725	713,701	2,606,708	851,008	2,805,293	836,702
Indigo ....do....	3,097,340	1,815,411	3,127,357	1,698,583	2,746,944	1,446,490	3,135,063	1,402,894	3,057,673	1,035,980
Licorice root *d* ....do....	70,136,591	1,171,621	98,432,319	1,566,830	106,333,199	1,667,256	100,105,654	1,737,097	109,077,323	1,926,993

Liquors, alcoholic:										
Distilled spirits—										
Of domestic manufacture, returned ... proof gallons	854,586	734,901	998,173	834,948	637,024	630,574	875,099	794,594	805,212	749,067
Brandy ... do	137,902	395,758	219,968	626,875	244,160	696,540	290,341	843,318	316,222	911,419
Other ... do	770,830	1,004,135	1,227,834	1,683,256	1,550,836	2,282,717	1,712,153	2,524,237	1,909,887	2,784,668
Total distilled spirits, proof gallons	1,763,318	2,134,794	2,445,975	3,145,079	2,482,020	3,609,831	2,877,593	4,162,149	3,031,321	4,445,154
Malt liquors—										
Unbottled ... gallons	1,777,202	506,428	1,928,672	570,692	2,228,502	647,533	2,447,555	719,092	2,553,105	718,183
Bottled ... do	733,535	695,102	918,562	917,186	1,081,818	1,079,723	1,151,891	1,166,123	1,198,406	1,161,965
Total malt liquors, gallons	2,510,737	1,201,530	2,847,234	1,487,878	3,310,320	1,727,256	3,599,446	1,885,215	3,751,511	1,880,148
Wines—										
Champagne and other sparkling ... dozen quarts	223,827	3,264,323	262,371	3,668,791	310,149	4,115,908	311,078	4,589,494	335,256	4,930,768
Still wines—										
Unbottled ... gallons	1,930,870	1,392,710	2,253,226	1,573,573	2,533,828	1,744,736	2,785,859	1,942,322	3,300,026	2,143,433
Bottled ... dozen quarts	268,921	1,312,147	274,873	1,347,842	315,950	1,560,851	373,832	1,687,420	297,818	1,846,937
Total still wines		2,704,857		2,921,415		3,305,587		3,629,742		3,990,370
Total wines		5,969,180		6,590,206		7,421,495		8,219,236		8,921,138
Total alcoholic liquors		9,305,504		11,223,163		12,758,582		14,266,600		15,246,640
Malt, barley. (*See* Grain and grain products.)										
Malt extract, fluid or solid		6,917		5,320		4,320		4,863		3,633
Malt liquors. (*See* Liquors, alcoholic.)										
Nursery stock (plants, trees, shrubs, vines, etc.) *e*		762,158		768,982		972,385		1,098,932		1,172,570
Oil cake ... pounds	2,159,849	8,799	1,885,648	9,553	208,657	1,437	448	64	2,614,059	20,740
Oil cake (substitute for india rubber)		(*b*)		1,149		846		(*b*)		(*b*)
Oils, vegetable:										
Fixed or expressed—										
Olive, salad ... gallons	736,877	923,804	930,042	1,090,250	967,702	1,170,871	983,059	1,266,293	1,330,097	1,573,410
Other		2,434,209		2,519,157		3,290,656		3,422,170		5,045,811
Total fixed or expressed		3,358,013		3,609,407		4,461,527		4,688,463		6,619,221

a Prior to 1902 exclusive of nuts free of duty, except cocoanuts.
b Not stated.
c Including buckwheat, buckwheat flour, corn meal, rye flour, bran and mill feed, and breadstuff preparations.
d Classed as agricultural for the first time in 1902. The statistics for earlier years are inserted merely for purposes of comparison, and are not included in the total agricultural imports for 1898-1901.
e Apparently including natural flowers free of duty prior to July 24, 1897.

Agricultural imports of the United States during the five years ended June 30, 1902—Continued.

Articles imported.	1898. Quantity.	1898. Value.	1899. Quantity.	1899. Value.	1900. Quantity.	1900. Value.	1901. Quantity.	1901. Value.	1902. Quantity.	1902. Value.
VEGETABLE MATTER—continued.										
Oils, vegetable—Continued.										
Volatile, or essential		$1,511,078		$1,691,257		$1,859,184		$1,959,395		$2,692,371
Total vegetable oils		4,869,091		5,300,664		6,320,711		6,647,858		8,718,591
Opium, crude ... pounds..	123,845	265,607	513,499	1,223,951	544,938	1,123,756	583,208	1,259,726	531,189	1,216,262
Opium, prepared ... do	100,258	652,341	124,214	828,203	142,479	1,065,965	117,581	972,582	(a)	(a)
Rice, rice meal, etc.:										
Rice ... do	129,810,630	2,793,111	153,837,026	3,152,771	93,648,451	1,904,915	74,598,061	1,588,044	75,674,776	1,596,210
Rice flour, rice meal, and broken rice ... pounds..	60,474,685	953,722	50,340,267	777,378	23,031,440	374,121	42,601,649	736,854	81,984,118	1,330,711
Total ... do	190,285,315	3,746,833	204,177,293	3,930,149	116,679,891	2,279,036	117,199,710	2,324,898	157,658,894	2,926,921
Sago, tapioca, etc		195,829		203,615		411,029		443,333		515,938
Seeds:										
Flaxseed, or linseed ... bushels..	136,098	150,515	81,953	87,602	67,379	94,126	1,631,726	2,098,207	477,157	724,082
Other		1,081,251		1,134,243		1,700,922		1,940,987		2,528,070
Total		1,231,766		1,221,845		1,795,048		4,039,194		3,252,152
Spices:										
Unground—										
Nutmegs ... pounds..	1,213,994	331,235	1,530,102	368,765	1,590,811	351,383	1,836,417	360,889	1,841,614	339,685
Pepper, black or white . do	14,080,136	909,711	12,332,747	1,083,100	13,085,333	1,283,635	16,081,849	1,806,167	16,046,179	1,752,345
Other [b] ... do	13,784,689	898,992	13,851,055	997,783	19,652,762	1,376,243	13,506,848	1,001,482	15,134,481	1,146,246
Total unground . do	29,078,819	2,139,938	27,713,901	2,449,648	34,328,906	3,011,261	31,425,114	3,168,538	33,022,274	3,233,276
Ground [c] ... do	2,658,706	264,691	3,346,925	332,653	4,516,709	390,004	3,786,623	394,571	4,460,841	446,966
Total spices ... do	31,737,525	2,404,629	31,060,829	2,782,301	38,845,615	3,401,265	35,211,737	3,563,109	37,483,115	3,685,242
Spirits, distilled. (*See* Liquors, alcoholic).										
Starch ... pounds..	6,120,924	103,780	8,542,897	140,528	11,767,924	222,296	7,302,501	179,340	11,714,931	235,645
Straw ... tons..	1,443	4,165	2,075	4,561	5,495	15,750	9,633	35,816	2,986	11,723
Sugar and molasses:										
Molasses ... gallons..	3,603,547	544,016	5,821,556	789,576	7,025,068	890,524	11,453,156	1,123,923	14,391,215	1,037,696

Sugar—										
Raw—*d*										
Beet .... pounds..	140,641,485	2,717,955	723,336,352	15,269,397	701,539,452	11,830,609	908,683,078	20,028,575	255,030,219	4,202,044
Cane .... do....	2,448,190,703	55,319,873	3,194,168,454	78,001,772	3,305,087,796	88,020,367	2,956,546,102	67,507,439	2,685,792,937	48,684,775
Total raw .... do....	2,588,832,188	58,037,828	3,917,504,806	93,271,169	4,006,627,248	99,850,976	3,865,229,180	87,536,014	2,940,823,156	52,886,819
Refined *e* .... do....	101,088,663	2,434,921	62,745,763	1,692,951	11,459,282	399,998	109,736,690	2,951,786	91,092,719	2,174,278
Total sugar ...... do....	2,689,920,851	60,472,749	3,980,250,569	94,964,120	4,018,086,530	100,250,974	3,975,005,870	90,487,800	3,031,915,875	55,061,097
Total sugar and molasses	....	61,016,765	....	95,753,696	....	101,141,498	....	91,611,723	....	56,098,793
Tea .... pounds..	71,957,715	10,654,283	74,089,899	9,675,081	84,845,107	10,558,110	89,806,453	11,017,876	75,579,125	9,380,198
Tobacco:										
Wrapper .... do....	3,988,561	3,913,294	4,147,048	4,349,034	5,561,068	5,122,359	6,574,586	5,940,857	5,729,879	5,084,606
Filler and other leaf *f* ..... do....	6,488,547	3,575,314	9,888,781	5,551,219	14,058,559	8,174,864	20,276,667	10,349,530	23,698,958	10,127,065
Total .... do....	10,477,108	7,488,608	14,035,829	9,900,253	19,619,627	13,297,223	26,851,253	16,290,387	29,428,837	15,211,671
Vanilla beans .... do....	63,997	279,755	272,174	1,235,412	255,966	1,209,334	248,988	875,229	331,739	859,309
Vegetables:										
Fresh or dried—										
Beans and dried pease, bushels	163,560	149,227	184,499	165,830	967,031	1,049,443	1,099,640	1,306,405	881,966	1,152,177
Onions .... bushels..	488,853	429,173	771,960	499,520	546,798	357,901	774,042	509,552	796,316	608,673
Potatoes .... do....	1,171,378	473,154	539,420	294,391	155,861	147,349	371,911	224,759	7,656,162	3,160,801
Other	....	239,733	....	312,673	....	371,963	....	366,971	....	536,581
Total fresh or dried	....	1,291,287	....	1,272,414	....	1,926,656	....	2,407,687	....	5,458,232
Prepared or preserved—										
Pickles and sauces	....	243,354	....	352,022	....	306,223	....	388,486	....	480,342
Other	....	499,959	....	554,302	....	702,198	....	923,506	....	1,101,261
Total prepared or preserved	....	743,313	....	906,324	....	1,008,421	....	1,311,992	....	1,581,603
Total vegetables	....	2,034,600	....	2,178,738	....	2,935,077	....	3,719,679	....	7,039,835
Vinegar .... gallons..	85,556	22,313	93,443	23,534	122,479	30,724	135,883	34,222	138,195	45,754
Wafers, unmedicated	....	11,797	....	14,733	....	15,629	....	18,651	....	17,148
Wines. (*See* Liquors, alcoholic.)										
Total vegetable matter.	....	213,658,788	....	257,688,943	....	279,051,986	....	285,105,336	....	276,611,388
Total agricultural imports	....	314,291,796	....	355,514,881	....	420,139,288	....	391,931,051		[illegible]

a No longer classed as agricultural. *b* Exclusive of dutiable. *c* Including dutiable unground. *d* Not above No. 16 Dutch standard in color.
e Including raw sugar above No. 16 Dutch standard in color, and also maple sugar and sirup. *f* Including stems.

Agricultural exports (domestic) of the United States during the five years ended June 30, 1902.

Articles exported.	1898. Quantity.	1898. Value.	1899. Quantity.	1899. Value.	1900. Quantity.	1900. Value.	1901. Quantity.	1901. Value.	1902. Quantity.	1902. Value.
ANIMAL MATTER.										
Animals, live:										
Cattle .... number..	439,255	$37,827,500	389,490	$30,516,833	397,286	$30,635,153	459,218	$37,566,980	392,884	$29,902,212
Hogs .... do....	14,411	110,487	33,031	227,241	51,180	394,813	22,318	238,465	8,368	88,330
Horses .... do....	51,150	6,176,569	45,778	5,444,342	64,722	7,612,616	82,250	8,873,845	103,020	10,048,046
Mules .... do....	8,098	664,789	6,755	516,908	43,369	3,919,478	34,405	3,210,267	27,586	2,692,298
Sheep .... do....	199,690	1,213,886	143,286	853,555	125,772	733,477	297,925	1,933,000	358,720	1,940,060
Other, including fowls	....	250,175	....	322,037	....	289,494	....	236,319	....	200,738
Total	....	46,243,406	....	37,880,916	....	43,585,031	....	52,058,876	....	44,871,684
Beeswax .... pounds..	151,094	41,827	152,494	41,916	319,379	91,913	140,276	39,464	125,283	36,541
Bones, hoofs, horns, and horn tips, strips, and waste	....	174,861	....	195,759	....	199,194	....	218,680	....	163,180
Bristles	....	(a)	....	(a)	....	1,446	....	3,968	....	17
Dairy products:										
Butter .... pounds..	25,690,025	3,864,765	20,247,997	3,263,951	18,266,371	3,143,509	23,248,526	4,014,905	16,002,169	2,885,609
Cheese .... do....	53,167,280	4,559,324	38,198,753	3,316,049	48,419,353	4,943,609	39,813,517	3,950,999	27,203,184	2,745,597
Milk	....	671,670	....	1,049,211	....	1,139,402	....	1,437,818	....	1,473,564
Total	....	9,095,759	....	7,629,211	....	9,226,520	....	9,403,722	....	7,104,770
Eggs .... dozens..	2,754,810	448,370	3,693,611	641,385	5,920,727	984,081	3,692,875	676,232	2,717,990	528,679
Egg yolks	....	(a)	....	10,379	....	883	....	1,610	....	14,760
Feathers	....	157,553	....	212,374	....	280,509	....	327,965	....	239,756
Fertilizer (refuse skins)	....	(a)	....	1,662	....	(a)	....	(a)	....	(a)
Fibers, animal:										
Silk waste .... pounds..	153,886	19,002	128,698	16,075	285,640	53,851	53,398	9,138	81,477	9,759
Wool .... do....	121,139	18,071	1,683,419	237,350	2,200,309	387,239	199,565	26,017	123,278	13,369
Total .... do....	275,025	37,073	1,812,117	253,425	2,485,949	441,090	252,963	35,155	204,755	23,128
Glue .... do....	2,318,711	209,441	2,368,087	222,072	2,349,014	225,844	2,703,400	254,447	2,907,632	284,413
Grease. (*See* Meat and meat products.)										
Hair [b]	....	635,716	....	503,712	....	676,688	....	674,881	....	633,337
Hides and skins, other than furs, pounds	11,536,673	1,015,032	10,140,840	929,117	7,496,256	802,674	11,161,749	1,084,952	9,372,747	906,504
Honey	....	98,504	....	55,900	....	30,191	....	55,574	....	106,112

Meat and meat products:										
Meat—										
Beef—										
Fresh ....pounds..	274,768,074	22,966,556	282,139,974	23,545,185	320,078,609	20,643,830	251,748,333	31,851,361	301,824,473	29,045,653
Cured—										
Salted or pickled, pounds..............	44,314,479	2,368,467	46,564,876	2,525,784	47,306,513	2,697,340	55,312,632	3,145,219	48,632,727	3,031,027
Other ....pounds..	1,589,052	150,051	1,579,313	145,996	2,319,165	197,051	789,285	72,677	818,382	72,836
Total cured ..do....	45,903,531	2,518,518	48,144,189	2,671,780	49,625,678	2,894,391	56,101,917	3,217,896	49,451,109	3,103,863
Canned............do....	37,109,570	3,279,657	38,385,472	3,503,293	55,553,745	5,233,982	53,445,521	5,307,501	66,645,838	6,646,130
Total beef....do....	357,781,175	28,764,731	368,669,635	29,720,258	434,258,032	37,772,203	461,295,771	40,376,758	417,921,420	38,795,049
Mutton................do....	329,169	27,961	379,110	29,427	773,769	64,313	691,121	46,643	430,351	37,067
Pork—										
Fresh...............do....	12,224,285	815,075	41,310,364	2,722,661	25,946,905	1,925,772	30,728,586	2,424,537	44,171,674	3,652,464
Cured—										
Bacon ....do....	650,108,933	46,380,918	532,651,480	41,557,067	512,153,729	38,975,915	456,122,741	37,499,026	383,150,624	35,446,797
Hams............do....	200,185,861	18,987,525	225,846,750	20,774,084	196,414,412	20,416,367	216,571,803	22,842,778	227,653,232	25,222,744
Salted or pickled, pounds..............	88,133,078	4,906,961	157,197,200	7,917,066	133,199,683	8,243,797	138,643,611	9,926,633	115,896,275	10,117,562
Total cured.pounds.	938,427,872	70,275,404	925,695,430	70,248,217	841,767,824	67,636,079	811,338,155	70,268,437	726,700,131	70,790,133
Canned.............do....	(c)	(c)	(c)	(c)	8,496,074	658,402	8,945,594	768,381	9,903,882	882,610
Total pork .. do....	950,652,157	71,990,479	967,005,794	72,970,878	876,210,803	70,220,253	851,012,335	73,401,355	780,475,087	75,275,477
Poultry and game............	....	85,729	....	183,593	....	463,965	....	1,070,190	....	356,601
Sausage and sausage meat, pounds....................	(c)	(c)	(c)	(c)	(c)	(c)	9,799,106	923,974	7,137,297	726,437
Canned meat, n. e. s.............	....	(c)	....	(c)	....	1,721,064	....	1,556,671	....	1,461,385
Total meat..........	....	90,968,910	....	102,904,066	....	110,244,738	....	117,375,591		117,982,216
Meat products—										
Grease, grease scraps, and other soap stock............	....	1,964,565	....	2,576,507	....	2,944,322	....	3,339,948	....	2,610,925
Lard ....pounds..	709,344,045	39,710,672	711,259,851	42,208,465	661,813,093	41,939,164	611,357,514	46,569,348	556,840,222	52,375,864
Lard compounds[d] .....do...	21,343,023	1,118,659	22,144,717	1,200,231	35,852,095	1,475,061	23,352,966	1,449,878	36,201,744	2,081,053

[a] Not stated.
[b] Including manufactures of.
[c] Included in "Other meat products."
[d] Including cottolene and lardine, and in 1900-1902 stearin.

Agricultural exports (domestic) of the United States during the five years ended June 30, 1902—Continued.

Articles exported.	1898.		1899.		1900.		1901.		1902.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
ANIMAL MATTER—continued.										
Meat and meat products—Cont'd.										
Meat products—Continued.										
Oils—										
Lard oil ....gallons..	775,102	$305,825	917,007	$412,447	738,724	$337,260	766,783	$438,645	460,035	$327,794
Oleo oil..........pounds..	132,579,277	7,904,413	142,330,492	9,183,659	146,739,681	10,503,856	161,651,413	11,846,373	138,546,088	12,254,969
Other..........gallons..	123,711	50,587	166,372	64,368	381,161	172,568	574,209	258,406	352,201	201,535
Total oils	....	8,260,825	....	9,660,474	....	11,013,684	....	12,543,424	....	12,784,298
Oleomargarine (imitation butter)..........pounds..	4,328,536	386,297	5,549,322	509,703	4,256,067	416,544	4,990,699	484,501	5,721,254	601,521
Sausage casings	....	1,821,519	....	1,671,052	....	2,307,571	....	2,778,854	....	1,795,044
Stearin..........pounds..	3,987,258	188,579	1,174,167	55,821	(a)	(a)	(a)	(a)	(a)	(a)
Tallow ....do....	81,744,809	3,141,653	107,361,009	4,367,356	89,030,943	4,398,204	77,166,389	3,848,561	34,065,758	1,924,577
Other [b]..........	....	4,193,078	....	5,834,865	....	3,941,394	....	3,212,009	....	3,624,764
Total meat products	....	60,785,847	....	68,084,474	....	68,435,947	....	74,217,323	....	78,404,646
Total meat and meat products....	....	160,754,757	....	170,988,540	....	178,680,685	....	191,592,914	....	195,896,862
Oils, animal. (*See* Meat and meat products.)										
Quill	....	14,413	....	12,213	....	11,105	....	8,281	....	6,168
Silk waste. (*See* Fibers, animal.)										
Stearin. (*See* Meat and meat products.)										
Wool. (*See* Fibers, animal.)										
Total animal matter [c]..........	....	218,926,712	....	219,577,981	....	235,239,654	....	256,416,722	....	250,815,851
VEGETABLE MATTER.										
Breadstuffs. (*See* Grain and grain products.)										
Broom corn..........	....	163,036	....	185,902	....	182,520	....	237,863	....	244,358
Broom root (rice root)..........	....	(d)	....	10,975	....	6,140	....	1,708	....	1,798
Cider..........gallons..	465,873	69,063	490,803	64,500	483,367	64,283	462,048	61,132	121,006	21,869
Cocoa, ground or prepared, and chocolate [c]..........	....	137,589	....	192,863	....	231,509	....	333,036	....	166,245

Coffee:										
Green or raw .... pounds	(d)	(d)	(d)	(d)	(d)	(d)	497,559	72,584	27,088,368	3,209,946
Roasted or prepared .... do	(d)	(f)	(d)	(f)	(d)	(f)	(d)	(f)	443,985	71,152
Total .... do	(d)	(d)	(d)	(d)	(d)	(d)	(d)	(d)	27,532,353	3,281,098
Compressed food		(d)		(d)		74,898		(d)		(d)
Cotton:										
Sea island .... bales	40,037	2,767,291	36,213	2,361,697	46,308	2,985,378	29,305	2,237,558	31,771	2,486,907
Sea island .... pounds	15,610,302		14,142,052		18,199,967		11,373,867		12,231,080	
Upland .... bales	7,549,967	227,674,924	7,337,169	207,203,077	6,043,826	228,847,259	6,479,145	311,435,885	6,841,921	288,164,912
Upland .... pounds	3,834,653,993		3,759,268,241		3,082,383,221		3,319,516,581		3,488,547,083	
Waste cotton .... pounds	12,521,574	511,004	14,308,829	524,802	25,642,400	1,156,241	28,171,912	1,431,604	28,195,873	946,537
Total .... do	3,862,785,869	230,953,219	3,787,719,122	210,089,576	3,126,225,588	242,988,978	3,259,062,360	315,105,047	3,528,974,636	291,598,356
Flowers, cut		2,967		2,355		4,169		1,787		4,788
Fruits and nuts:										
Fruits—										
Fresh or dried—										
Apples, fresh .... barrels	605,390	1,684,717	380,222	1,210,459	526,636	1,444,655	883,673	2,058,964	459,719	1,628,886
Apples, dried .... pounds	31,031,254	1,837,725	19,305,739	1,245,733	34,964,010	2,247,851	28,309,023	1,510,581	15,654,468	1,190,593
Apricots, dried .... do	(d)	(d)	(d)	(d)	(d)	(d)	(d)	(d)	1,928,367	178,143
Oranges		339,396		282,313		271,468		436,560		420,835
Prunes .... pounds	15,940,791	1,021,888	5,615,565	330,847	25,922,371	1,646,382	10,621,564	589,113	23,358,849	1,404,422
Raisins .... do	3,109,639	167,062	4,659,807	242,620	2,415,456	139,689	3,512,164	218,715	2,323,274	149,216
Other		2,033,845		1,997,649		2,515,451		2,716,269		2,153,050
Total fresh or dried		7,144,633		5,359,621		8,295,446		7,530,202		7,125,145
Preserved—										
Canned		1,624,741		2,330,715		3,127,278		3,006,109		1,195,635
Other		82,504		66,899		63,448		71,597		94,323
Total preserved		1,707,245		2,397,614		3,190,726		3,077,706		1,289,958
Total fruits		8,851,878		7,757,235		11,486,172		10,607,908		8,415,103
Nuts		161,432		140,250		156,490		218,743		304,241
Total fruits and nuts		9,013,310		7,897,485		11,642,662		10,826,651		8,719,344
Ginseng .... pounds	171,063	628,446	196,196	782,545	169,961	878,710	149,069	801,672	154,063	856,515
Glucose and grape sugar .... do	196,864,605	2,871,830	229,003,571	3,624,890	221,901,479	3,600,139	204,203,974	3,113,898	130,419,611	2,019,286

[a] Included in "Lard compounds."

[b] In 1898-1899 including canned meat, except canned beef; in 1898-1900 including sausage and sausage meat; and throughout the period including meats if any, not elsewhere specified.

[c] To these totals for the years 1898-1901, as stated in previous publications, has been added the value of lard compounds, an item hitherto classed as vegetable matter.

[d] Not stated.

[e] Prior to 1902 including coffee, roasted or prepared.

[f] Included in "Cocoa, ground or prepared, and chocolate."

Agricultural exports (domestic) of the United States during the five years ended June 30, 1902—Continued.

Articles exported.	1898.		1899.		1900.		1901.		1902.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
VEGETABLE MATTER—continued.										
Grain and grain products:										
Grain—										
Barley .... bushels..	11,237,077	$5,542,040	2,267,403	$1,375,274	23,661,662	$11,216,694	6,293,207	$2,883,565	8,714,268	$3,995,363
Buckwheat .... do....	1,370,403	589,285	1,533,980	846,028	426,822	254,847	123,540	79,120	719,615	449,917
Corn (maize) .... do....	208,744,939	74,196,850	174,089,094	68,977,448	209,348,284	85,206,400	177,817,965	82,527,983	26,636,552	16,185,673
Oats .... do....	69,130,288	20,632,914	30,309,778	9,787,540	41,369,415	12,504,654	37,146,812	11,765,330	9,971,139	4,153,238
Rye .... do....	15,541,575	8,825,769	10,140,866	5,936,078	2,355,792	1,442,655	2,326,882	1,321,979	2,697,863	1,581,491
Wheat .... do....	148,231,261	145,684,659	139,432,815	104,269,169	101,950,389	73,237,080	132,060,667	96,771,743	154,856,102	112,875,222
Total grain ... do....	454,255,543	255,471,517	357,773,936	191,191,537	379,112,364	183,861,730	355,769,073	195,349,729	203,595,539	139,240,844
Grain products—										
Meal and flour—										
Corn meal ...... barrels..	827,651	1,766,068	791,488	1,775,868	943,782	2,148,410	896,877	2,065,432	348,034	1,046,643
Oatmeal .... pounds..	85,500,350	1,757,978	53,042,595	1,295,988	66,229,950	1,547,900	92,198,138	2,308,649	59,516,512	1,617,298
Rye flour .... barrels..	2,410	11,815	4,826	15,015	4,370	14,757	3,105	10,860	2,369	8,406
Wheat flour .... do....	15,349,943	69,263,718	18,485,690	73,093,870	18,699,194	67,760,886	18,650,979	69,459,296	17,759,203	65,661,974
Total meal and flour	....	72,799,579	....	76,180,741	....	71,471,953	....	73,844,237	....	68,334,318
Bran, middlings, and mill feed .... tons..	91,189	1,329,519	127,953	2,002,588	166,604	2,638,719	79,358	1,383,246	48,980	962,595
Malt .... bushels..	406,702	287,473	453,038	324,145	296,742	215,198	357,947	250,099	401,575	266,894
Malt sprouts	....	15,124	....	55,177	....	62,266	....	(a)	....	(a)
Distillery and brewery refuse .... tons..	(b)	(c)	(b)	(c)	(b)	(c)	59,136	992,836	66,843	1,157,636
Breadstuff preparations—										
Bread and biscuit, pounds.	15,990,558	788,264	16,447,430	809,998	18,329,815	938,513	12,420,325	606,811	11,641,411	601,136
Other	....	1,765,207	....	2,133,110	....	2,362,715	....	2,832,930	....	2,295,018
Total breadstuff preparations	....	2,553,471	....	2,943,108	....	3,301,228	....	3,439,741	....	2,896,154
All other	....	1,743,033	....	1,681,725	....	1,470,448	....	584,838	....	629,797
Total grain products	....	78,728,199	....	83,187,481	....	79,159,812	....	80,494,997	....	74,160,394
Total grain and grain products	....	334,199,716	....	274,379,021	....	263,021,542	....	275,844,717	....	213,401,238

Grasses, dried	....	26,499	....	26,063	....	20,148	....	18,295	....	18,001
Hay ....tons	81,827	1,151,273	61,916	858,992	72,716	992,741	89,264	1,473,876	153,421	2,580,622
Hops ....pounds	17,161,659	2,642,779	21,145,512	3,926,144	12,639,474	1,707,660	14,965,676	2,466,515	10,715,151	1,550,657
Lard substitutes. (*See* Meat and meat products.)										
Liquors, alcoholic:										
Distilled spirits—										
Alcohol,[d] including cologne spirits ......proof gallons	1,619,220	463,616	1,476,028	427,288	177,974	59,277	237,509	97,633	367,528	220,453
Brandy ....do	24,886	39,455	20,944	29,289	80,259	83,698	15,223	28,176	24,077	30,174
Rum ....do	607,634	845,673	850,719	1,175,306	670,410	903,808	1,076,711	1,468,110	1,095,401	1,425,920
Whisky—										
Bourbon ....do	286,599	241,066	224,918	267,865	863,241	764,860	525,372	687,969	611,518	638,061
Rye ....do	17,425	31,164	99,884	156,617	91,721	121,241	160,357	251,583	155,046	275,717
Total whisky ..do	304,024	272,230	324,802	424,482	954,962	886,101	685,729	939,552	766,564	913,778
Other ....do	36,869	30,149	19,536	24,372	18,585	24,921	23,562	44,670	76,384	82,950
Total distilled spirits, proof gallons	2,592,713	1,651,123	2,692,029	2,080,737	1,902,190	1,957,805	2,038,834	2,578,141	2,329,964	2,673,275
Malt liquors—										
Unbottled ....gallons	391,802	88,548	602,055	154,751	731,411	194,157	333,696	79,508	417,025	89,769
Bottled ......dozen quarts	406,231	497,031	1,433,799	1,723,373	1,578,240	1,945,059	1,351,779	1,643,517	822,899	1,190,293
Total malt liquors	....	585,579	....	1,878,124	....	2,139,216	....	1,723,025	....	1,280,062
Wines—										
Unbottled ....gallons	1,623,163	682,028	1,498,078	624,315	1,408,859	575,665	1,117,858	461,560	929,900	407,345
Bottled ......dozen quarts	9,672	46,721	10,973	52,015	9,854	49,927	9,901	43,013	10,952	42,980
Total wines	....	728,749	....	676,320	....	625,592	....	504,573	....	450,325
Total alcoholic liquors	....	2,965,451	....	4,645,191	....	4,722,613	....	4,805,739	....	4,413,662
Malt. (*See* Grain and grain products.)										
Malt liquors. (*See* Liquors, alcoholic.)										
Malt sprouts. (*See* Grain and grain products.)										
Nursery stock	....	96,330	....	134,929	....	107,172	....	134,961	....	132,027

[a] Included in "Distillery and brewery refuse."
[b] Not stated.
[c] Included partly in "Malt sprouts" and partly in "All other grain products."
[d] Exclusive of wood alcohol.

Agricultural exports (domestic) of the United States during the five years ended June 30, 1902—Continued.

Articles exported.	1898.		1899.		1900.		1901.		1902.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
VEGETABLE MATTER—continued.										
Oil cake and oil-cake meal:										
Corn ....pounds..	2,202,680	$20,286	1,922,264	$17,623	4,888,776	$48,783	12,703,209	$131,774	14,740,498	$164,056
Cotton-seed ....do....	919,727,701	8,040,710	1,079,993,479	9,253,398	1,143,704,342	11,229,188	1,258,687,317	13,119,968	1,050,466,246	12,271,009
Flaxseed, or linseed ......do....	436,206,321	4,540,824	487,177,390	5,277,744	483,130,182	5,528,331	455,154,860	5,471,930	582,886,875	7,508,133
Total ....do....	1,358,136,702	12,601,820	1,569,093,133	14,548,765	1,631,723,300	16,806,302	1,726,545,386	18,723,672	1,648,093,619	19,943,198
Oils, vegetable:										
Fixed or expressed—										
Corn ....gallons..	2,646,560	575,646	2,360,623	565,293	4,383,926	1,351,867	4,808,545	1,831,980	4,266,398	1,769,370
Cotton-seed ....do....	40,230,784	10,137,619	50,627,219	12,077,519	46,902,390	14,127,538	49,356,741	16,541,321	33,042,848	12,992,393
Linseed ....do....	90,074	38,439	107,000	47,681	103,494	54,148	99,919	66,653	102,116	68,617
Other	....	885,057	....	838,257	....	554,781	....	363,056	....	220,372
Total fixed or expressed	....	11,636,761	....	13,528,750	....	16,088,334	....	18,803,010	....	15,050,752
Volatile, or essential—										
Peppermint ....pounds..	145,375	180,811	117,462	118,227	89,558	90,298	60,166	63,672	33,301	54,898
Other	....	201,497	....	162,358	....	166,424	....	169,004	....	202,983
Total volatile, or essential	....	382,308	....	280,585	....	256,722	....	232,676	....	257,881
Total vegetable oils	....	12,019,069	....	13,809,335	....	16,345,056	....	19,035,686	....	15,308,633
Rice, rice meal, etc.:										
Rice ....pounds..	637,146	27,501	852,704	38,511	12,947,009	500,364	1,078,958	42,807	615,036	29,707
Rice bran, meal, and polish.do....	5,563,841	35,498	14,481,985	80,298	28,119,408	167,023	24,418,888	143,922	28,976,238	228,010
Total ....do....	6,200,987	62,999	15,334,689	118,809	41,066,417	667,387	25,527,846	186,729	29,591,274	257,717
Rice root. (*See* Broom root.)										
Root beer........dozen quarts..	(*a*)	(*a*)	(*a*)	(*a*)	3,439	4,661	1,751	2,018	712	1,014
Roots, herbs, and barks, n. e. s......	....	147,839	....	169,828	....	237,527	....	275,150	....	290,692
Seeds:										
Cotton ....pounds..	32,764,781	197,258	34,443,806	197,023	49,855,238	346,230	43,329,257	366,953	56,403,344	509,627
Flaxseed, or linseed....bushels..	257,228	231,237	2,830,991	2,815,449	2,743,266	3,475,417	2,755,683	4,319,102	3,874,033	6,031,887

Grass seed—										
Clover ....pounds..	31,155,381	1,892,101	19,980,434	1,264,922	32,069,371	2,379,372	11,998,674	1,063,506	7,256,573	594,733
Timothy ....do....	10,238,780	317,173	16,149,611	492,710	15,078,186	505,758	7,275,806	296,640	5,966,986	373,046
Other	....	167,109	....	156,200	....	165,063	....	144,948	....	315,556
Total grass seed....	....	2,376,383	....	1,913,832	....	3,050,193	....	1,505,094	....	1,283,335
All other seeds	....	149,845	....	153,092	....	165,142	....	193,666	....	202,975
Total seeds	....	2,954,723	....	5,079,396	....	7,036,982	....	6,384,815	....	8,027,824
Spices	....	3,841	....	2,257	....	19,131	....	20,204	....	23,471
Spirits, distilled. (*See* Liquors, alcoholic.)										
Starch ....pounds..	72,806,313	1,371,549	110,193,776	2,292,843	124,935,963	2,604,362	102,800,725	2,005,865	28,183,967	656,705
Straw	....	5,907	....	4,737	....	4,209	....	5,328	....	5,092
Sugar, molasses, and sirup:										
Molasses ....gallons..	3,817,829	267,202	5,682,080	444,392	3,892,374	434,585	2,495,638	291,063	2,911,509	416,470
Sirup ....do....	7,573,541	791,727	10,070,650	1,465,849	11,139,770	1,682,202	15,092,321	2,235,014	14,865,744	2,048,561
Sugar—										
Raw ....pounds..	460,682	17,353	403,119	14,275	322,252	11,262	147,221	6,056	359,402	14,089
Refined ....do....	6,047,608	301,511	9,462,228	426,202	22,192,351	1,004,135	8,727,639	437,523	7,213,050	292,715
Total sugar ..do....	6,508,290	318,864	9,865,347	440,477	22,514,603	1,015,397	8,874,860	443,579	7,572,452	306,804
Total sugar, molasses, and sirup.....	....	1,380,793	....	2,350,718	....	3,132,184	....	2,969,656	....	2,771,835
Teasels	....	13,230	....	19,466	....	21,882	....	25,079	....	23,161
Tobacco:										
Leaf ....pounds..	252,258,902	21,924,337	272,421,295	25,170,771	334,604,210	29,163,086	306,900,931	27,475,466	291,369,700	26,881,641
Stems and trimmings.....do....	10,761,312	247,243	11,191,827	296,447	10,051,487	259,285	8,886,848	181,009	9,637,665	222,355
Total ....do....	263,020,214	22,171,580	283,613,122	25,467,218	344,655,697	29,422,371	315,787,782	27,656,475	301,007,365	27,103,996
Vegetables:										
Fresh or dried—										
Beans and pease.....bushels..	854,284	1,094,094	883,201	1,269,812	617,355	983,401	468,670	862,088	324,481	636,345
Onions ....do....	100,148	90,832	164,902	134,250	171,636	143,256	165,391	144,030	113,531	117,019
Potatoes ....do....	605,187	460,666	579,833	450,739	809,472	626,791	741,483	518,621	528,484	564,550
Total fresh or dried, bushels	1,559,619	1,645,592	1,627,936	1,854,801	1,598,463	1,753,448	1,375,544	1,524,739	966,496	1,317,914

[a] Not stated.

Agricultural exports (domestic) of the United States during the five years ended June 30, 1902—Continued.

Articles exported.	1898.		1899.		1900.		1901.		1902.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
VEGETABLE MATTER—continued.										
Vegetables—Continued.										
Prepared or preserved—										
Canned		$386,039		$555,691		$603 288		$528,914		$560,612
Other *a*		350,157		388,908		496,542		544,764		667,761
Total prepared or preserved		736,196		944,599		1,099,830		1,073,678		1,228,373
Total vegetables		2,381,786		2,799,400		2,853,278		2,598,417		2,546,287
Vinegar ... gallons	108,657	12,939	107,317	13,488	115,372	12,583	83,780	13,231	95,675	19,754
Wines. (*See* Liquors, alcholic)										
Yeast		41,770		36,061		8,086		6,809		8,439
Total vegetable matter *b*		640,092,234		573,233,752		609,376,876		635,211,669		606,297,682
Total agricultural exports		859,018,946		792,811,733		844,616,530		951,628,331		857,113,533

a Chiefly pickles, sauces, and relishes, but including also some fresh vegetables.
b From these totals for the years 1898-1901, as stated in previous publications, has been deducted the value of lard compounds, an item now classed as animal matter.

AVERAGE PRICES FOR IMPORTS AND EXPORTS.

[From Division of Foreign Markets.]

Average import price of agricultural products imported into the United States during each of the five fiscal years 1898–1902.

[The import prices of merchandise here given represent "the actual market value or wholesale price of such merchandise as bought and sold in usual wholesale quantities, at the time of exportation to the United States, in the principal markets of the country from whence imported, and in the condition in which such merchandise is there bought and sold for exportation to the United States, or consigned to the United States for sale, including the value of all cartons, cases, crates, boxes, sacks, and coverings of any kind, and all other costs, charges, and expenses incident to placing the merchandise in condition, packed ready for shipment to the United States." (Act of June 10, 1890.)

The export prices are the actual market values in the port of shipment.]

Articles imported.	Year ended June 30—				
	1898.	1899.	1900.	1901.	1902.
ANIMAL MATTER.					
Animals, live:					
Cattle—					
For breeding purposes ....head..	$132.81	$152.81	[illegible]	[illegible]	[illegible]
Other ....do....	9.75	11.17	11.42	11.45	13.11
Total cattle ....do....	9.99	11.62	12.47	13.23	16.75
Horses—					
For breeding purposes ....do....	181.82	277.65	278.25	374.15	432.61
Other ....do....	117.92	129.01	131.64	144.59	160.82
Total horses ....do....	134.49	181.15	[illegible]	[illegible]	[illegible]
Sheep—					
For breeding purposes ....do....	14.05	19.25	19.91	24.11	22.63
Other ....do....	2.73	3.36	3.47	3.60	3.44
Total sheep ....do....	2.82	3.47	3.58	3.73	[illegible]
Beeswax ....pound..	.266	.243	.241	.261	.284
Bristles:					
Crude, unsorted ....do....	.346	.579	.823	.433	.702
Sorted, bunched, or prepared ....do....	.814	.788	.851	1.05	1.02
Total ....do....	.814	.785	.851	1.03	1.02
Cochineal ....do....	.290	.238	.198	.178	.179
Dairy products:					
Butter ....do....	.171	.167	.196	.208	.173
Cheese ....do....	.134	.132	.131	.138	.149
Eggs ....dozen..	.049	.095	.065	.083	.037
Fibers, animal:					
Silk—					
Cocoons ....pound..	.381	.169	.608	1.05	.412
Raw, or as reeled from the cocoon ..do....	3.05	3.28	3.96	3.21	3.31
Waste ....do....	.374	.421	.427	.551	.571
Total silk ....do....	2.66	2.89	3.47	2.89	3.00
Wool and hair of the camel, goat, alpaca, and like animals—					
Class 1, clothing ....pound..	.175	.150	.214	.164	.120
Class 2, combing ....do....	.199	.272	.269	.196	.176
Class 3, carpet ....do....	.096	.094	.091	.085	.082
Total wool ....do....	.126	.108	.130	.121	.106
Total animal fibers ....do....	....	....	....	.374	.384
Glue ....do....	.104	.089	.096	.104	.100
Hides and skins, other than furs:					
Cattle hides ....do....	.108	.104	.118	.113	.118
Goatskins ....do....	.243	.265	.268	.279	.289
Other ....do....	.140	.148	.165	.167	.168
Total ....do....	.151	.157	.167	.172	.178
Honey ....gallon..	.395	.409	.482	.459	.337
Meat products:					
Oils ....do....	.404	.173	.180	.217	.189
Stearin ....pound..	....	.014	.018	.018	.004
VEGETABLE MATTER.					
Argols, or wine lees ....pound..	.083	.082	.087	.087	.077
Broom corn ....ton..	....	....	90.37	103.00	110.60
Cider ....gallon..	....	....	.864	.790	.894
Cocoa and chocolate:					
Cocoa—					
Crude, and leaves and shells of..pound..	.136	.143	.136	.141	.130
Prepared or manufactured ....do....	.357	.319	.310	.296	.304
Total cocoa ....do....	.143	.147	.140	.144	.133
Chocolate ....do....	.151	.187	.189	.197	.193
Total cocoa and chocolate ....do....	.143	.148	.141	.145	.136
Coffee ....do....	.075	.066	.067	.074	.065

Average import price of agricultural products imported into the United States during each of the five fiscal years 1898–1902—Continued.

Articles imported.	Year ended June 30—				
	1898.	1899.	1900.	1901.	1902.
VEGETABLE MATTER—continued.					
Coffee substitutes:					
Chicory root—					
Raw, unground ....pound..	$0.016	$0.015	$0.015	$0.019	$0.020
Roasted, ground, or otherwise prepared, pound	....	.033	.034	.032	.035
Total chicory root........pound..	....	.027	.019	.024	.028
Other........do....	.034	.037	.039	.044	.051
Total coffee substitutes ......do....	....	.033	.028	.034	.038
Fibers, vegetable:					
Cotton........do....	.095	.100	.118	.146	.119
Flax ....ton....	215.88	201.81	236.30	273.44	269.55
Hemp ....do....	139.49	121.06	132.43	153.52	167.48
Istle, or Tampico fiber........do....	50.84	64.31	82.65	70.08	63.34
Jute and jute butts........do....	22.65	27.61	38.53	42.78	34.49
Manila hemp........do....	64.44	116.77	168.27	162.69	186.97
Sisal grass ....do....	74.58	128.12	153.17	113.77	133.52
Other........do....	62.22	68.74	81.36	95.46	107.61
Fruit juices, n. e. s.:					
Prune juice or prune wine ....gallon..	.890	.776	.815	.713	.769
Other, including cherry juice........do....	.489	.517	.617	.498	.519
Total ....do....	.621	.631	.707	.600	.668
Fruits and nuts:					
Fruits, fresh or dried—					
Currants........pound..	.033	.026	.025	.057	.034
Dates........do....	.027	.025	.021	.020	.017
Figs ....do....	.053	.049	.058	.046	.044
Lemons ....do....	....	.019	.023	.024	.020
Oranges........do....	....	.013	.016	.014	.015
Plums and prunes ....do....	.130	.106	.108	.084	.084
Raisins ....do....	.058	.057	.052	.077	.060
Nuts—Almonds........do....	.115	.123	.150	.184	.126
Ginger, preserved or pickled........do....	....	.044	.042	.051	.043
Grain and grain products:					
Grain—					
Barley ....bushel..	.351	.486	.480	.492	.579
Corn (maize) ....do....	.433	.388	.783	.661	.734
Oats ....do....	.370	.385	.442	.434	.468
Rye........do....	.404	2.44	1.11	.717	1.10
Wheat ....do....	.952	.752	.759	.697	.663
Total grain ....do....	.907	.705	.639	.646	.624
Grain products—					
Meal and flour—					
Oatmeal ....pound..	.055	.059	.057	.057	.058
Wheat flour ....barrel..	4.46	4.48	5.26	5.34	6.21
Malt, barley........bushel..	.925	.892	.938	1.01	.970
Hay ....ton..	8.92	5.81	7.09	7.91	7.88
Hops ....pound..	.273	.449	.276	.326	.297
Indigo........do....	.586	.543	.527	.447	.339
Licorice root........do....	.017	.016	.016	.017	.018
Liquors, alcoholic:					
Distilled spirits—					
Of domestic manufacture, returned, proof gallon	.830	.836	.918	.908	.931
Brandy ....proof gallon..	2.87	2.85	2.85	2.90	2.88
Other........do....	1.30	1.37	1.47	1.47	1.46
Total distilled spirits ....do....	1.21	1.29	1.45	1.45	1.47
Malt liquors—					
Unbottled ....gallon..	.285	.296	.291	.294	.281
Bottled........do....	.948	.999	.998	1.01	.970
Total malt liquors ....do....	.479	.523	.522	.524	.501
Wines—					
Champagne and other sparkling, dozen quarts	14.53	13.98	13.27	14.75	14.71
Still wines—					
Unbottled........gallon..	.721	.698	.689	.697	.650
Bottled ....doz. qts..	4.88	4.90	4.94	4.51	4.64
Oil cake........pound..	.004	.005	.007	.143	.008
Oils, vegetable: Olive, salad ....gallon..	1.25	1.17	1.21	1.29	1.18
Opium, crude........pound..	2.14	2.38	2.06	2.16	2.28
Opium, prepared ....do....	6.51	6.67	7.48	8.27	....
Rice, rice meal, etc.:					
Rice ....do....	.022	.020	.020	.021	.021
Rice flour, rice meal, and broken rice..do....	.016	.015	.016	.017	.016
Total ....do....	.020	.019	.020	.020	.019
Seeds: Flaxseed, or linseed........bushel..	1.11	1.07	1.40	1.29	1.52

Average import price of agricultural products imported into the United States during each of the five fiscal years 1898–1902—Continued.

Articles imported	Year ended June 30—				
	1898.	1899.	1900.	1901.	1902.
VEGETABLE MATTER—continued.					
Spices:					
Unground—					
Nutmegs……pound..	$0.273	$0.241	$0.221	$0.197	$0.184
Pepper, black or white……do….	.065	.088	.098	.112	.109
Other……do….	.065	.072	.070	.074	.076
Total unground……do….	.074	.088	.088	.101	.098
Ground……do….	.100	.099	.086	.104	.100
Total spices……do….	.076	.090	.088	.101	.098
Starch……do….	.017	.016	.019	.025	.020
Straw……ton..	3.08	2.20	2.87	3.72	3.93
Sugar and molasses:					
Molasses……gallon..	.151	.136	.127	.098	.072
Sugar—					
Raw—					
Beet……pound..	.019	.021	.021	.022	.016
Cane……do….	.023	.024	.026	.023	.018
Total raw……do….	.022	.024	.025	.023	.018
Refined……do….	.024	.027	.034	.027	.024
Total sugar……do….	.022	.024	.025	.023	.018
Tea……do….	.140	.131	.124	.123	.124
Tobacco:					
Wrapper……do….	.981	1.05	.921	.904	.887
Filler and other leaf……do….	.551	.561	.581	.510	.427
Total……do….	.715	.705	.678	.607	.517
Vanilla beans……do….	4.37	4.54	4.72	3.52	2.38
Vegetables, fresh or dried.					
Beans and dried pease……bushel..	.912	.899	1.09	1.19	1.31
Onions……do….	.878	.647	.655	.658	.764
Potatoes……do….	.404	.555	.945	.604	.413
Vinegar……gallon..	.261	.252	.251	.252	.272

Average export price of domestic agricultural products exported from the United States during each of the five fiscal years 1898–1902.

Articles exported.	Year ended June 30—				
	1898.	1899.	1900.	1901.	1902.
ANIMAL MATTER.					
Animals, live:					
Cattle……number..	$86.12	$78.35	$77.11	$81.81	$76.11
Hogs……do….	7.67	6.88	7.71	10.68	10.56
Horses……do….	120.75	118.93	117.62	107.89	97.53
Mules……do….	82.09	76.52	90.38	93.31	97.60
Sheep……do….	6.08	5.96	5.83	6.49	5.41
Beeswax……pound..	.277	.275	.288	.281	.292
Dairy products:					
Butter……do….	.150	.161	.172	.173	.180
Cheese……do….	.086	.087	.102	.099	.101
Eggs……dozen..	.163	.174	.166	.183	.195
Fibers, animal:					
Silk waste……pound..	.123	.125	.189	.171	.120
Wool……do….	.149	.141	.176	.130	.108
Total……do….	.135	.140	.177	.139	.113
Glue……do….	.090	.094	.096	.094	.098
Hides and skins, other than furs……do….	.088	.092	.107	.095	.097
Meat and meat products:					
Meat—					
Beef—					
Fresh……do….	.084	.083	.090	.091	.096
Cured—					
Salted or pickled……do….	.053	.054	.057	.057	.062
Other……do….	.094	.092	.085	.092	.089
Total cured……do….	.055	.055	.058	.057	.063
Canned……do….	.088	.091	.094	.099	.100
Total beef……do….	.080	.081	.087	.088	.093
Mutton……do….	.085	.078	.083	.067	.086
Pork—					
Fresh……do….	.067	.066	.074	.079	.083
Cured—					
Bacon……do….	.071	.074	.076	.082	.093
Hams……do….	.095	.092	.104	.105	.111
Salted or pickled……do….	.056	.058	.062	.072	.087
Total cured……do….	.075	.076	.080	.087	.097
Canned……do….	………	………	.077	.079	.087
Total pork……do….	.075	.075	.080	.086	.096
Sausage and sausage meat……do….	………	………	………	.094	.102

Average export price of domestic agricultural products exported from the United States during each of the five fiscal years 1898–1902—Continued.

Articles exported.	Year ended June 30— 1898.	1899.	1900.	1901.	1902.
ANIMAL MATTER—continued.					
Meat and meat products—Continued.					
Meat products—					
Lard ......pound..	$0.056	$0.059	$0.063	$0.076	$0.094
Lard compounds ......do....	.052	.054	.057	.062	.074
Oils—					
Lard oil ......gallon..	.395	.450	.457	.572	.713
Oleo oil ......pound..	.060	.064	.072	.073	.088
Other ......gallon..	.409	.387	.453	.450	.572
Oleomargarine (imitation butter) pound..	.089	.092	.098	.097	.105
Stearin ......do....	.047	.048	......	......	......
Tallow ......do....	.038	.041	.049	.050	.056
VEGETABLE MATTER.					
Cider ......gallon..	.129	.131	.133	.132	.181
Coffee:					
Green or raw ......pound..	......	......	......	.146	.118
Roasted or prepared ......do....	......	......	......	......	.160
Total ......do....	......	......	......	......	.119
Cotton:					
Sea island ......bale....	69.12	65.22	64.47	76.35	78.28
Sea island ......pound..	.177	.167	.164	.197	.203
Upland ......bale....	30.19	28.24	39.52	48.07	42.12
Upland ......pound..	.059	.055	.077	.094	.083
Waste cotton ......pound..	.041	.037	.045	.051	.034
Total ......do....	.060	.055	.078	.094	.083
Fruits, fresh or dried:					
Apples, fresh ......barrel..	2.78	3.18	2.74	2.33	3.54
Apples, dried ......pound..	.061	.065	.064	.053	.076
Apricots, dried ......do....	......	......	......	......	.092
Prunes ......do....	.064	.068	.054	.059	.060
Raisins ......do....	.054	.052	.058	.062	.064
Ginseng ......do....	3.67	3.99	5.18	5.38	5.56
Glucose and grape sugar ......do....	.015	.016	.016	.015	.018
Grain and grain products:					
Grain—					
Barley ......bushel..	.493	.607	.474	.458	.458
Buckwheat ......do....	.430	.552	.597	.640	.625
Corn (maize) ......do....	.355	.396	.407	.464	.608
Oats ......do....	.298	.323	.302	.317	.417
Rye ......do....	.568	.585	.612	.568	.586
Wheat ......do....	.983	.748	.718	.733	.729
Total grain ......do....	.562	.534	.485	.549	.684
Grain products—					
Meal and flour—					
Corn meal ......barrel..	2.13	2.24	2.28	2.30	3.01
Oatmeal ......pound..	.021	.022	.023	.025	.027
Rye flour ......barrel..	3.46	3.11	3.38	3.50	3.55
Wheat flour ......do....	4.51	3.95	3.62	3.72	3.70
Bran, middlings, and mill feed ......ton..	14.58	15.65	15.84	17.43	19.65
Malt ......bushel..	.707	.715	.725	.699	.665
Distillery and brewery refuse ......ton..	......	......	......	16.79	17.32
Bread and biscuit ......pound..	.049	.049	.051	.049	.052
Hay ......ton..	14.07	13.23	13.65	16.53	16.82
Hops ......pound..	.154	.171	.135	.165	.145
Liquors, alcoholic:					
Distilled spirits—					
Alcohol, including cologne spirits, proof gallon	.283	.289	.333	.411	.600
Brandy ......proof gallon..	1.59	1.49	1.04	1.84	1.25
Rum ......do....	1.39	1.38	1.35	1.36	1.30
Whisky—					
Bourbon ......do....	.841	1.19	.886	1.31	1.04
Rye ......do....	1.78	1.57	1.32	1.57	1.78
Total whisky ......do....	.895	1.31	.928	1.37	1.19
Other ......do....	.818	1.25	1.34	1.90	1.09
Total distilled spirits ......do....	.637	.773	1.03	1.26	1.15
Malt liquors—					
Unbottled ......gallon..	.226	.257	.255	.238	.218
Bottled ......doz. qts..	1.22	1.21	1.23	1.22	1.46
Wines—					
Unbottled ......gallon..	.420	.417	.409	.413	.438
Bottled ......doz. qts..	4.83	4.74	5.07	4.34	3.92
Oil cake and oil-cake meal:					
Corn ......pound..	.009	.009	.010	.010	.011
Cotton-seed ......do....	.009	.009	.010	.010	.012
Flaxseed, or linseed ......do....	.010	.011	.011	.012	.013
Total ......do....	.009	.009	.010	.011	.012

Average export price of domestic agricultural products exported from the United States during each of the five fiscal years 1898–1902—Continued.

Articles exported.	Year ended June 30—				
	1898.	1899.	1900.	1901.	1902.
VEGETABLE MATTER—continued.					
Oils, vegetable:					
Fixed or expressed—					
Corn .... gallon..	$0.218	$0.239	$0.368	$0.381	$0.415
Cotton seed .... do....	.252	.239	.301	.335	.393
Linseed .... do....	.427	.446	.523	.667	.672
Volatile, or essential—Peppermint .. pound..	1.24	1.01	1.01	1.06	1.51
Rice, rice meal, etc.:					
Rice .... do....	.043	.045	.039	.040	.048
Rice bran, meal, and polish .... do....	.006	.006	.006	.006	.005
Total .... do....	.010	.008	.016	.007	.009
Root beer .... doz. qts..	....	....	1.36	1.15	1.42
Seeds:					
Cotton .... pound..	.006	.006	.007	.008	.009
Flaxseed, or linseed .... bushel..	.899	.995	1.27	1.57	1.56
Grass seed—					
Clover .... pound..	.061	.063	.074	.089	.082
Timothy .... do....	.031	.031	.034	.041	.063
Starch .... do....	.019	.021	.021	.020	.023
Sugar, molasses, and sirup:					
Molasses .... gallon..	.070	.078	.112	.117	.143
Sirup .... do....	.105	.146	.151	.148	.138
Sugar—					
Raw .... pound..	.038	.035	.035	.041	.039
Refined .... do....	.050	.045	.045	.050	.041
Total sugar .... do....	.049	.045	.045	.050	.041
Tobacco:					
Leaf .... do....	.087	.092	.087	.090	.092
Stems and trimmings .... do....	.023	.026	.026	.020	.027
Total .... do....	.084	.090	.085	.088	.090
Vegetables, fresh or dried:					
Beans and pease .... bushel..	1.28	1.44	1.59	1.84	1.96
Onions .... do....	.907	.814	.835	.871	1.03
Potatoes .... do....	.761	.777	.774	.699	1.07
Total .... do....	1.06	1.14	1.10	1.11	1.36
Vinegar .... gallon..	.119	.126	.109	.158	.206

Imported animals quarantined in 1902.

Station.	Cattle.	Sheep.	Hogs.
Littleton, Mass	60	42	....
Garfield, N. J	62	8	5
Athenia, N. J	588	118	7
Halethorp, Md	227	....	....
Port Huron, Mich	22	....	....
Detroit, Mich	2	2	1
Sault Ste. Marie, Mich	2	....	....
Ogdensburg, N. Y	1	....	....
Hogansburg, N. Y	6	....	....
Alexandria Bay, N. Y	4	....	....
Cape Vincent, N. Y	2	....	....
Buffalo, N. Y	49	....	....
Charlotte, N. Y	2	....	....
Richford, Vt	8	2	5
Newport, Vt	19	8	....
Island Pond, Vt	1	5	3
Beecher Falls, Vt	101	1	....
Houlton, Me	45	59	4
Vanceboro, Me	4	....	....
Calais, Me	4	6	1
San Francisco, Cal	5	....	7
Total	1,214	231	33

There were also imported through the port of New York and quarantined under the supervision of the Athenia, N. J., station, 123 animals other than domestic, including 46 deer, 43 camels, 9 antelopes, 5 aoudads, and 2 elephants. Similar importations at other points bring the total of imported animals that were quarantined up to 1,649.

RATIO OF POPULATION TO AREA.

The following table from Bulletin 24, Division of Statistics, shows the changes in density of population of the several States, as reported by the census enumerators each ten years from 1850 to 1900. It affords an opportunity for comparisons with statistics of the principal crops, including acreage, yield, etc., from 1866 to the present, as presented on page 761 and following pages. The areas given, it will be noted, include only land.

Areas in 1900 and density of population of the United States for fifty years, by States.

[The density of population is obtained by dividing the population of each State and Territory and of the United States by its total land area in square miles at each census. In computing density of population for the United States, the areas and population of Alaska and Hawaii in 1900, of Alaska in 1890, and of Indian Territory in 1860, 1870, and 1880 are not considered. The area of Indian reservations, outside of Indian Territory, is included in the area of the States and Territories in which they are severally situated, and in that of the United States prior to 1890, although the population of these Indian reservations was not ascertained, and for this reason can not be considered in figuring density of population at the censuses prior to 1890. See Vol. I, part 1, Pop., Census 1900.]

States and Territories.	Land area, 1900.	Number per square mile.					
		1850.	1860.	1870.	1880.	1890.	1900.
	Sq. mi.						
Maine	29,895	19.5	21	21	21.7	22.1	23.2
New Hampshire	9,005	35.3	36.2	35.3	38.5	41.8	45.7
Vermont	9,135	34.4	34.5	36.2	36.4	36.4	37.6
Massachusetts	8,040	123.7	153.1	181.3	221.8	278.5	348.9
Rhode Island	1,053	136	160.9	200.3	254.9	318.4	407
Connecticut	4,845	76.5	95	110.9	128.5	154	187.5
New York	47,620	65	81.5	92	106.7	126.1	152.6
New Jersey	7,525	65.7	90.1	121.5	151.7	193.8	250.3
Pennsylvania	44,985	51.4	64.6	78.3	95.2	116.9	140.1
Delaware	1,960	46.7	57.3	63.8	74.8	86	94.3
Maryland	9,860	59.1	69.7	79.2	94.8	105.7	120.5
District of Columbia	60	861.5	1,251.3	2,195	2,960.4	3,839.9	4,645.3
Virginia	40,125	21.9	24.6	30.5	37.7	41.3	46.2
West Virginia	24,645	......	......	17.9	25.1	31	38.9
North Carolina	48,580	17.9	20.4	22.1	28.8	33.3	39
South Carolina	30,170	22.2	23.3	23.4	33	38.2	44.4
Georgia	58,980	15.4	17.9	20.1	26.1	31.2	37.6
Florida	54,240	1.6	2.6	3.5	5	7.2	9.7
Ohio	40,760	48.6	57.4	65.4	78.5	90.1	102
Indiana	35,910	27.5	37.6	46.8	55.1	61.1	70.1
Illinois	56,000	15.2	30.6	45.4	55	68.3	86.1
Michigan	57,430	6.9	13	20.6	28.5	36.5	42.2
Wisconsin	54,450	5.6	14.2	19.4	24.2	31.1	38
Minnesota	79,205	(a)	2.2	5.6	9.9	16.5	22.1
Iowa	55,475	3.5	12.2	21.5	29.3	34.5	40.2
Missouri	68,735	9.9	17.2	25	31.5	39	45.2
North Dakota	70,195	......	(b)	(b)	(b)	2.7	4.5
South Dakota	76,850					4.5	5.2
Nebraska	76,840	......	.1	1.6	5.9	13.8	13.9
Kansas	81,700	......	.9	4.5	12.2	17.5	18
Kentucky	40,000	24.6	28.9	33	41.2	46.5	53.7
Tennessee	41,750	24	26.6	30.1	36.9	42.3	48.4
Alabama	51,540	15	18.7	19.3	24.5	29.4	35.5
Mississippi	46,340	13.1	17.1	17.9	24.4	27.8	33.5
Louisiana	45,420	11.4	15.6	16	20.7	24.6	30.4
Texas	262,290	.8	2.3	3.1	6.1	8.5	11.6
Indian Territory	31,000	......	......	......	......	5.8	12.6
Oklahoma	38,830	......	......	......	......	2	10.3
Arkansas	53,045	4	8.2	9.1	15.1	21.3	24.7
Montana	145,310	......	......	.1	.3	1	1.7
Wyoming	97,575	......	......	.1	.2	.6	.9
Colorado	103,645	......	.3	.4	1.9	4	5.2
New Mexico	122,460	.3	.4	.8	1	1.3	1.6
Arizona	112,920	......	......	.1	.4	.8	1.1
Utah	82,190	.1	.2	1.1	1.8	2.6	3.4
Nevada	109,740	......	.1	.4	.6	.4	.4
Idaho	84,290	......	......	.2	.4	1.1	1.9
Washington	66,880	......	.1	.4	1.1	5.3	7.7
Oregon	94,560	(c)	.6	1	1.8	3.4	4.4
California	155,980	.6	2.4	3.6	5.5	7.8	9.5
United States	2,970,038	7.9	10.8	13.3	17.3	21.2	25.6

a 0.03. b Dakota Territory, 1860, 0.03; 1870, 0.1; 1880, 0.9. c 0.04.

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